AECOM
625 West Ridge Pike
Conshohocken, Pennsylvania 19428

610.832.3500 tel
610.832.3501 fax

March 15, 2018

New Jersey Department of Environmental Protection
Attn: Ken Komar
Division of Water Supply & Geoscience
Bureau of Water Allocation & Well Permitting
Mail Code 401-04Q
401 East State Street
Trenton, New Jersey 08625

Subject: **NJDEP Water Allocation Permit Application, Temporary Dewatering**
Transcontinental Gas Pipe Line Company, LLC
Northeast Supply Enhancement Project – Madison Loop
Old Bridge Township, Middlesex County, New Jersey

Dear Mr. Komar,

AECOM is submitting the enclosed application to the New Jersey Department of Environmental Protection Division of Water Supply and Geoscience, Bureau of Water Allocation and Well Permitting for the above-referenced project on behalf of Transcontinental Gas Pipe Line Company, LLC (Transco).

On March 27, 2017, Transco filed an application with the Federal Energy Regulatory Commission (FERC) requesting a Certificate of Public Convenience and Necessity (Certificate) under Section 7(c) of the Natural Gas Act (NGA). The Project has been assigned Docket No. CP17-101-000 b FERC. The docket may be accessed at www.ferc.gov.

Transco, a subsidiary of Williams Partners L.P. (Williams), proposed the Northeast Supply Enhancement Project (Project) to support National Grid's long-term growth, reliability, and flexibility beginning in the 2019/2020 heating season. Transco is proposing to expand its existing interstate natural gas pipeline system in Pennsylvania and New Jersey and its existing offshore natural gas pipeline system in New Jersey and New York waters. The Project capacity is fully subscribed by two entities of National Grid: Brooklyn Union Gas Company (d/b/a [doing business as] National Grid NY) and KeySpan Gas East Corporation (d/b/a National Grid), collectively referred to herein as "National Grid". To provide the incremental 400,000 dekatherms per day (Dth/d) of capacity, Transco plans to expand portions of its system from the existing Compressor Station 195 in York County, Pennsylvania, to the Rockaway Transfer Point in New York State waters.

In New Jersey the Project entails the following components:

Onshore Pipeline Facilities

Madison Loop*

- **3.43 miles of 26-inch-diameter pipeline from Compressor Station 207 at MP8.57 to MP12.00 southwest of the Morgan meter and regulating (M&R) Station, located on the existing Transco pipeline Old Bridge Township and the Borough of Sayreville, Middlesex County, New Jersey.**

Raritan Bay Loop

- 0.16 mile of 26-inch-diameter pipeline from MP12.00 west-southwest of the Morgan M&R Station to the Sayreville shoreline at MP12.16.

Offshore Pipeline Facilities

Raritan Bay Loop

- 23.33 miles of 26-inch-diameter pipeline from MP12.16 at the Sayreville shoreline in Middlesex County, New Jersey, to MP35.49 at the Rockaway Transfer Point in the Lower New York Bay, New York, south of the Rockaway Peninsula in Queens County, New York.

Aboveground Facilities

New Compressor Station 206

- Construction of a new 32,000 ISO (International Organization for Standardization) horsepower (hp) compressor station and related ancillary equipment in Franklin Township, Somerset County, New Jersey, with two Solar Mars® 100 (or equivalent) natural gas-fired, turbine-driven compressors.

This permit application is specific to that portion of the Madison Loop within Old Bridge Township, Middlesex County*. Construction activities for the Project along the 3.43 mile Madison Loop will require excavation dewatering along areas of the pipeline trench as described in the attached application. **In order to maintain practicality in the required diversion reporting, Transco requests that monthly water allocation reports will be relative to the total diversion from the project by municipality, and not relative to individual diversions along the pipeline.**

Attached with this letter are the following documents in support of Transco's application:

- Application Fee;
- Checklist for the Application Form BWA-002;
- Form BWA-002 (including associated figures and attachments); and
- Technical Report (with supporting information).

Should the NJDEP have any questions regarding the proposed Project or submitted application or if you require any additional information, please contact the undersigned at (610) 832-8819. Thank you for your assistance.

Yours sincerely,

Heather Brewster

Heather L. Brewster
Senior Project Manager
heather.brewster@aecom.com

cc: K. Olson - Transco
File

Transcontinental Gas Pipe Line Company, LLC

Northeast Supply Enhancement Project

Madison Loop
Old Bridge Township, Middlesex County

New Jersey Department of Environmental Protection
Division of Water Supply & Geoscience
Bureau of Water Allocation & Well Permitting

Water Allocation Permit Application
Temporary Dewatering (BWA-002)

March 2018

TABLE OF CONTENTS

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER SUPPLY & GEOSCIENCE
BUREAU OF WATER ALLOCATION & WELL PERMITTING

WATER ALLOCATION PERMIT APPLICATION
TEMPORARY DEWATERING (BWA-002)

TRANSCONTINENTAL GAS PIPE LINE COMPANY, LLC
NORTHEAST SUPPLY ENHANCEMENT PROJECT
MADISON LOOP – BOROUGH OF SAYREVILLE

SECTION	ITEM

SECTION 1	**TEMPORARY DEWATERING APPLICATION FORM (BWA-002), CHECKLIST AND SUPPORTING DOCUMENTATION** including:
	• BWA-002 Checklist
	• BWA-002 Permit Application Form
	  • Table A.3 – Property Owner Information
	  • Table A.4 – Summary of Project Permits
	  • Table D.5 – Proposed Dewatering Locations
	  • Figure E.1.A – Proposed Dewatering Withdrawal Sources
	  • Figure E.1.B – Water Supply Wells in ¼ mile radius
	  • Figure E.1.C – Landfills and Groundwater Contamination in ¼ mile radius
	  • Table E.2.A – Well Summary Table
	  • Table E.2.B – Summary of Landfills and Groundwater Contamination in ¼ mile radius
	  • Figure F.1 – Groundwater Depth in Feet over Site

SECTION 2	**TECHNICAL REPORT**

SECTION 1

TEMPORARY DEWATERING APPLICATION FORM (BWA-002),
CHECKLIST AND SUPPORTING DOCUMENTATION

DEWATERING CHECKLIST 8/2013

WATER ALLOCATION APPLICATION NO. _______

For Application Form BWA – 0002

Northeast Supply Enhancement Project - Madison Loop - Old Bridge Township

A. Location and Property Information –
 __X__ Items 1 through 6 completed ***See also* Figure E.*1.A and* Table *A*.3**

B. Certifications
 __X__ 1, 2. Highest ranking individual
 __X__ 3, 4. Additional certifications when necessary

C. Required Submittals
 __X__ 2. Technical Report
 Include: depth to water; depth of excavations; calculations of dewatering volumes; calculation of worst case radius of influence (including how values used were obtained); source of hydrogeologic values used; impacts to: other users (wells, including domestic wells), the resource; how diversion is in the public interest; and potential for spreading contamination and causing salt water intrusion.

D. Diversion Request and Diversion Source Information
 __X__ 1. Present allocation (source aquifer/allocations, mgm, mgy, gpm)
 __X__ 2. Requested allocation (source aquifer/allocations, mgm, mgy, gpm)
 __X__ 3. Diversion use
 __X__ 4. Dewatering sources and depth range
 __X__ 5. Source information
 __X__ 5. Addendum A completed ***See also Table D.5***

E. Mapping Requirements
 __X__ 1. USGS quad sheet including ***See Figures E.1.*A*, E.1.*B*, and E.1.C***
  __X__ a. existing and proposed dewatering sources
  __X__ b. all water supply wells within ¼ mile radius (see *Note 1*)
  __X__ c. contamination sites within ¼ mile radius (see *Note 1*)
 __X__ 2. Summary tables for ***See Table E.2.*A**
  __X__a. water supply wells with owner's name, well permit #, well depth, pump capacity and setting, distance to withdrawal, geological formation
  __X__b. contamination sites with site name, distance to withdrawal, geological formation impacted, and site status ***See Table E.2.*B**

F. Dewatering Information
 __X__ 1. Duration
 __X__ 2. Estimated start date
 __X__ 3. Estimated completion date
 __X__ 4. Length and depth of trenches
 __X__ 5. Average diversion including supporting calculations
 __X__ 6. Excavation depths
 __X__ 7. Depths to groundwater
 __X__ 8. Discharge/NJPDES information

See Section F of Application Form, Addendum A, Table D.5, and the Technical Report

Note 1 – larger radius may be required if dewatering depth is greater than 50 feet

BWA-002
Revised 6/2017

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
MAIL CODE 401-04Q
DIVISION OF WATER SUPPLY & GEOSCIENCE
BUREAU OF WATER ALLOCATION & WELL PERMITTING
P.O. BOX 420
TRENTON, NEW JERSEY 08625-0420
(609) 984-6831

TEMPORARY DEWATERING PERMIT APPLICATION

PLEASE READ THE INSTRUCTIONS BEFORE COMPLETING THIS APPLICATION FORM.
Provide all requested information, as applicable.

A. LOCATION AND PROPERTY INFORMATION

The Department is now maintaining a single database of regulated sites. The following information will prevent unnecessary duplication of data.

1. APPLICANT/RESPONSIBLE ENTITY

Name Transcontinental Gas Pipeline Company, LLC

Address 2800 Post Oak Boulevard

City or Town Houston State TX Zip Code 77056 +

Telephone ( ) 713-215-4130 E-Mail karen.olson@williams.com

Organization Type: (Check one)
☐ Authority/District/Commission ☐ Municipal ☐ County ☐ State
☐ Commercial/Industry ☐ Individually Owned ☐ Utility ■ Corporation
☐ Investor (Non-BPU) ☐ Investor (BPU) ☐ Other ____________

APPLICANT CONTACT INFORMATION

Applicant Contact for the Applicant/Responsible Entity above:

Application Contact Name Karen Olson Title Environmental Scientist

Address 2800 Post Oak Blvd., Level 11

City or Town Houston State Texas Zip Code 77056 +

Telephone (713) 215-4232 E-Mail karen.olson@williams.com

If an agent has been authorized under Section B. Certifications of this application to act as the Applicant's Agent in all matters pertaining to the application, please check here: ■

REPORT FORM RECIPIENT/ PERMIT CONTACT

Contact for permit information and monitoring reports:

Name Heather Brewster Title Assoc. Vice President

Address 625 West Ridge Pike

City or Town Conshohocken State PA Zip Code 19428 +

Telephone ( ) 610-832-8819 E-Mail heather.brewster@aecom.com

2. Billing Contact

Billing should go to mailing address of (check one):

■ Applicant/Responsible Entity in No. 1 ☐ Applicant Contact Name in No. 1 ☐ Report Form Recipient in No. 1

Name Transcontinental Gas Pipeline Company, LLC Telephone ( ) 713-215-4232 E-Mail karen.olson@williams.com

3. Actual Diversion Location(s) and Property/Land Owner(s) Information

Project Name (For facilities pending or under construction, use the proposed facility name)
Northeast Supply Enhancement Project (NESE) - Madison Loop

Street Address/Location (or nearest cross streets if no address is available; P.O. Boxes are not acceptable)
N/A - Pipeline Right-of-Way

City or Town Old Bridge State NJ Zip Code ________+_______

Does the activity span multiple municipalities? Yes ■ No ☐ Does the activity span multiple counties? Yes ☐ No ■

Municipality	Block	Lot	Owner	Specify Type of Access Approval*
			Refer to Table A.3	

(ATTACH ADDITIONAL SHEETS IF NECESSARY)
*Include copy of Access Approval for each parcel

4. Other Permits/Agencies

Provide the following for any other state, local or federal permit that has been applied for in relation to this project.

Permit Type	Application/Permit Number and Program Interest Number	Application Date	Application Status
● New Jersey Pollutant Discharge Elimination System (NJPDES)			
● Land Use Permits (Freshwater Wetlands)			
● Hazardous Waste Management Program	Refer to Table A.4		
● Water Quality Management Plan Amendment			
● Relevant Environmental Permits – Including Federal State, & Local Approvals Specify:			

Is the project located within the New Jersey Pinelands Area? Yes ☐ No ■

If this application is for a new or modified permit, and is located in the New Jersey Pinelands Area, then a Certificate of Filing from the New Jersey Pinelands Commission must be submitted with the application. The Pinelands Commission can be contacted at (609) 894-7300.

B. CERTIFICATIONS

1. APPLICANT/RESPONSIBLE ENTITY

This certification is to be signed by the highest-ranking individual as follows:

(a) For a corporation, by a principal executive officer of at least the level of vice president; or
(b) For a partnership or sole proprietorship, by a general partner or the proprietor, respectively; or
(c) For a municipality, State, Federal or other public agency, by either the principal executive officer or ranking elected official.

I certify under penalty of law that the information provided in this document is true, accurate and complete. I am aware that there are significant civil and criminal penalties for submitting false, inaccurate or incomplete information, including fines and/or imprisonment.

3-12-18
Date

Timothy L Powell
Signature

Timothy L. Powell
Name (please print)

Director, Land & Permits
Title

2. APPLICANT'S AGENT (IF APPLICABLE)

I, the Applicant/Responsible Entity Timothy L. Powell *authorize to act as my agent/representative in all matters pertaining to my application the following person:*

Name Heather Brewster Title Assoc. Vice President

Company/Employer AECOM

Address 625 West Ridge Pike County Montgomery

City or Town Conshohocken State PA Zip Code 19428

Telephone ( ) 610-832-8819 E-Mail heather.brewster@aecom.com

COMMONWEALTH OF PENNSYLVANIA
NOTARIAL SEAL
Denise Haly Gerstlauer, Notary Public
Plymouth Twp., Montgomery County
My Commission Expires Feb. 5, 2020
MEMBER, PENNSYLVANIA ASSOCIATION OF NOTARIES

Denise Haly Gerstlauer

Timothy L Powell
(Signature of Applicant/Responsible Entity)

APPLICANT'S AGENT'S CERTIFICATION
I agree to serve as the Applicant's Agent for the above-mentioned Applicant/ Responsible Entity

(Signature of Applicant's Agent)

Sworn before me
this 14th day of
March 2018
Denise Haly Gerstlauer
Notary Public

Commonwealth of Pennsylvania
County of Montgomery

3. Statement of Preparer of Plans, Specifications, Surveyors or Technical Report (if applicable)

I hereby certify that the engineering plans, specifications and engineer's report applicable to this project comply with N.J.A.C. 7:19 et seq.

(Signature of Preparer and Date)

Peter J. Dudko, Jr.
Name and Title (Print)

Principal Engineer, AECOM
Position, Name of Firm

PROFESSIONAL SEAL, if applicable

C. REQUIRED SUBMITTALS/ APPLICATION ATTACHMENTS

Check here to ensure the following are included with the application:

Included		
■	1.	Permit Application Fee (not required for renewal applications)
■	2.	Technical Report (not required for renewal applications)
■	3.	Copies of Access Agreement(s) for each parcel listed in Section A.3.
■	4.	**Send a PDF version of this application and attachments to: waterallocation@dep.nj.gov**

D. DIVERSION REQUEST AND DIVERSION SOURCE INFORMATION

This application is for: (Please check one, as appropriate)

The quantities at D.2 represent the maximum estimate of monthly withdrawal (=2x total project estimate, see Table D.5) at a maximum rate of 150 gpm.

- ■ New Diversion, not previously permitted
- ☐ Modification of Existing Permit No. ___________ Activity No. (if known) _________________
- ☐ Renewal of Existing Permit No. ___________ Activity No. (if known) _________________

Attach additional sheets if space provided is not adequate.

1. Present Allocation:

   a. All Sources: N/A million gallons of water per month at a maximum rate of N/A gallons per minute.

2. Requested Allocation:

   a. All Sources: 6 million gallons of water per month at a maximum rate of 150 gallons per minute.

   Note: This allocation represents the maximum withdrawal expected during any one month (31 days) of the calendar year.

3. Diversion to be used for the temporary dewatering of Trenches and Excavation associated with construction of the project.

4. Dewatering will occur from a series of _______wells, ________wellpoints, and/or X trenches ranging from 7 to 15 feet deep.

5. Complete the following for each existing and proposed dewatering wells, wellpoints, site-wide wells/wellpoints system, and/or trenches:

Dewatering State Well Permit No./ Site Wide Permit No. *	Well Local Name/ Trench Name	Location Description	Existing (E) Proposed (P)	Proposed Maximum Withdrawal Rate (million gallons)	
				Per Month	Per Year
		Refer to attached Table D.5			

** Provide the Dewatering State Well Permit Number for the dewatering well or well point or provide the State Site-Wide Permit Number for each dewatering wells/well points. For dewatering activities where a well permit is not required according to N.J.A.C. 7:9D-1.11(g), provide the well/trench local name only.*

6. Complete Addendum A for each existing and proposed dewatering diversion source.

E. MAPPING REQUIREMENTS

1. Attach a U.S.G.S. 7 ½ minute quadrangle or State Atlas Map depicting the location of the following:

Included		
■	a.	Each existing and proposed dewatering withdrawal source see Figure E.1.a
■	b.	All water supply wells within a one quarter mile radius see Figure E.1.b
■	c.	Landfills and ground water contamination sites within a one quarter mile radius see Figure E.1.c

2. Associated Required Summary Tables for Mapping :

Included		see Table E.2.a
■	a.	For Items 1b, provide a **summary table** with the owner's name, well permit number, well depth, pump capacity and setting, distance to applicant's withdrawal sources, and geological formation for each groundwater withdrawal. **DO NOT SUBMIT COPIES OF INDIVIDUAL WELL RECORDS.**
■	b.	For Item 1c, provide a summary table with the site name, distance to applicant's withdrawal sources, and geological formations impacted. see Table E.2.b

NOTE: If the project will include any dewatering wells deeper than 50 feet, the items listed in 1b. and 1c. above may be required for a radius greater than one-quarter mile.

F. DEWATERING INFORMATION

1. Dewatering will occur for a period of ________ days or 12 months.
2. Estimated dewatering start date 01/01/2019.
3. Estimated dewatering completion date 12/31/2019.

the value 5,120 ft is the total length of open cut trenches and excavations, whether or not they require dewatering.

4. Total length of the project is 9,507 linear feet (LF). Total length of construction trenches 5,120 LF, maximum length of open trench 250 LF, trench width 5 LF, maximum depth of trenches 15 LF.
5. The average diversion, in gallons of water per foot of open trench, will be 963 gallons/foot (supporting calculations must be provided). see Table D.5

   calculated as total estimated diversion of 2.96 Mgal divided by 3,077 ft length of active construction trench (not including HDD portions) - see Table D.5
6. Dewatering is expected to occur to a depth of 15 feet below grade. Excavation over the site will vary from 7 to 15 feet.
7. Depth, in feet, to groundwater over the site is from 1 to 107 feet. see Figure F.1
8. Ground surface elevations at the site vary from 16 to 127 feet above sea level. see Figure F.1 and Table D.5
9. The estimated quantity of the monthly diversion is based upon estimated (or observed) permeability of soils and estimated two-sided line flow to open trench, or Dupuit-Forchtheimer approximation for HDD launch and exit pits.
10. Water will be discharged to the ground surface on-site utilizing applicable NJ SESC BMPs and discharge permits.

    The discharge will be measured by a totalizing flow meter.

see Table D.5 for the description of sub-divided trench segments along the overall construction trench 99.23 - 193.30, located in Old Bridge Township, Middlesex County

DEWATERING ADDENDUM A
SOURCE DATA FOR GROUNDWATER WELLS AND TRENCHES

Complete Well/Trench information for all existing and proposed sources. This information is mandatory. Refer to instructions for acceptable values. Please reference the same State Well Permit Numbers and Well Names as referenced in Section D of the application. Attach additional copies of addendum as needed.

State Well Permit No.	N/A
Well Local Name	N/A
Date Drilled	N/A
Total Finished Depth (feet) (include tailpiece if any)	N/A
Depth to Top of Open Hole Interval or Screen (feet)	N/A
Depth to Bottom of Open Hole Interval or Screen (feet)	N/A
Rated Pump Capacity (gpm)	N/A
Yield (gpm)	N/A
Aquifer/Geological Formation	N/A
Elevation Information:	
Site Elevation	N/A
Elevation System Description	N/A
Elevation Method Description	N/A
Absolute Elevation Accuracy	N/A
Absolute Elevation Accuracy Units (feet or meters)	N/A
Locational Information:	
X coordinate of well center (e.g. State Plane, Easting)	N/A
Y coordinate of well center (e.g. State Plane, Northing)	N/A
Coordinate System Code and Description	N/A
Coordinate Method Description	N/A
Absolute Location Accuracy	N/A
Accuracy Units (feet or meters)	N/A

Trench Segment Name	99.23 - 193.30	
Date Excavated	01/2019 - 12/2019	
Depth (feet)	7 - 15	
Width (feet)	5	
Length (feet)	9,407	
Rated Pump Capacity (gpm)	150	*consistent with section D.2*
Aquifer/Geological Formation	Alluvium (Qal), Pennsauken Fm. (Tb), Magothy Fm. (Km)	
Elevation Information:		
Site Elevation	16.4 - 126.7	
Elevation System Description	Feet above sea level	
Elevation Method Description	Licensed Surveyor	
Absolute Elevation Accuracy	+/- 0.5	
Absolute Elevation Accuracy Units (feet or meters)	Feet	
Locational Information:		
X coordinate of center (e.g. State Plane, Easting)	551,058	
Y coordinate of center (e.g. State Plane, Northing)	578,683	
Coordinate System Code and Description	01	
Coordinate Method Description	New Jersey State Plane 83 - USFEET	
Absolute Location Accuracy	+/- 10	
Accuracy Units (feet or meters)	Feet	

Instructions for Completing BWA-002

1. General Instructions

This form includes Sections A through F and Dewatering Addendum A. **All applicable sections must be completed or the application will be returned.** Applications must reference valid State Well Permit Numbers and wells must be permitted for their intended use. A well search can be scheduled by the applicant or performed by the Department for a fee. **Applications without valid State Well Permit Numbers for existing wells will be returned.**

All information required by N.J.A.C. 7:19-2.3 must be addressed in this application.

A. Location and Property Information

1. Applicant/Responsible Entity– Provide the name, as it is legally referred to, of the Applicant/Responsible Entity for this project. The Applicant/Responsible Entity is the firm, public agency, individual, or other entity which has the primary management and decision making authority over the project and not the contractor.

   Applicant Contact– Provide the information of the individual responsible for all aspects/inquiries regarding the application. Check the Applicant's Agent box if an Agent has been designated in Section B.2. of the application.

   The Report Form Recipient/Permit Contact is the designated individual responsible for completing Quarterly Monitoring Report Forms. Reports will be available through this link: http://www.nj.gov/dep/online/.

2. Billing Contact – Check the box of the appropriate address and indicate the individual's contact name for all billing inquiries.

3. Actual Diversion Location(s) and Property/Land Owner(s) - Provide the Project Name and the physical street address or nearest cross streets of the diversion location. Attach additional sheets as needed if more than one physical location applies. In the table, provide information regarding the municipality, block, lot, owner(s) of the property/land on which each diversion is located, and specify the relevant type of Access Approval such as an access agreement, eminent domain, etc.

4. Other Permits/Agencies – Provide information for all other permits necessary for the project and diversion activities, as indicated.

B. Certifications – Provide Certifications as indicated in Section B.

C. Required Submittals/Application Attachments

1. For new or modified permits, the appropriate application fee shall be submitted with the application. Refer to Section 3 of the instructions for fee schedule.
2. For details regarding the requirements of the Technical Report, refer to N.J.A.C. 7:19-2.3(c-g).
3. Provide copies of Access Approval for each parcel listed in A.3.
4. Send a PDF version of this application with attachments to waterallocation@dep.nj.gov.

Complete Sections D through F as indicated.

2. Instructions for Completing Dewatering Addendum A

The following tables provide the acceptable values for completing Dewatering Addendum A.

Elevation Information- Absolute elevation accuracy is the uncertainty in feet or meters of the elevation measurement.

Elevation System Description
Feet above sea level
Meters above sea level

Elevation Method Description
Approximate address match
DEP program database
Digital image
Exact address match
GPS
Hard copy match
Licensed Surveyor
Topographic Map
Plot Plan
Proposed Elevation-Digital Image
Proposed Elevation-Hard Copy Map

Location Information

USGS quadrangle maps have the coordinate system printed on the map. GPS units can usually be set to display a variety of coordinate systems. New Jersey State Plane 83 – USFEET is the State standard.

Coordinate System Code	Coordinate System Description*
01	New Jersey State Plane 83 – USFEET
22	Lat/Long (NAD27) – Decimal Degrees
27	Lat/Long (NAD27) – DMS
21	Lat/Long (NAD83) – Decimal Degrees
20	Lat/Long (NAD83) – DMS
09	New Jersey State Plane 27 – USFEET
02	New Jersey State Plane 83 – Meters
26	UTM (NAD27) – Meters
08	UTM Zone 18N – Meters
03	UTM Zone 18N (78 W to 72 W) – Kilometers

Coordinate Method Description
GPS
DEP Program Database
Exact Address Match
Digital Image (such as i-Map)
Hard Copy Map
Other (Describe)
Approximate Address Match
Proposed Location - Digital Image (such as i-Map)
Proposed Location - Hard Copy Map

Absolute location accuracy is the uncertainty in feet or meters of the location from actual ground truth. Modern GPS units can provide this number.

3. Permit Application Fee Schedules

From the following tables, determine the relevant Fee class for this Permit, based upon the maximum monthly allocation (from all sources) requested in this application.

Class 1: From 3.1 mgm to less than 15.5 mgm
Class 2: From 15.5 mgm to less than 31 mgm
Class 3: From 31 mgm to less than 62 mgm
Class 4: From 62 mgm to less than 155 mgm
Class 5: From 155 mgm to less than 310 mgm
Class 6: From 310 mgm and above

Find the proper fee in the following schedules according to the class (size).

1. An applicant for a new or modified permit may pay the application fee in full in accordance with the following schedule:

	Class 1, 2, and 3	Class 4, 5, and 6
Fees for New and Modification Permit Applications	$7275	$18595

2. An applicant for a new or modified permit may pay the application fee in three installments pursuant to N.J.S.A. 13:1D-120 through 13:1D-124, in accordance with the following schedule:

		Class 1, 2, and 3	Class 4, 5, and 6
Installment Plan Fees for New and Modification Permit Applications	(1) (2) (3)	$2425 $2425 $2425	$6195 $6195 $6205
TOTALS		$7275	$18595

NOTE: (1) - First installment (due with application)
(2) - Second installment (due 20 days after notice of administrative completeness)
(3) - Third installment (due 20 days after notice of Department's final decision)

Please note that payment of the application fee in installments will delay the permitting process, as additional time is necessary for billing, payment processing and various administrative tasks associated with this option.

Please make checks payable to: "**Treasurer, State of New Jersey**". If you need assistance with determination of the fee, contact the Bureau of Water Allocation & Well Permitting at (609) 984-6831.

TABLE A.3 – PROPERTY OWNER INFORMATION

Table A.3

Property and Land Owner Information (Old Bridge Township)
Northeast Supply Enhancement (NESE) Project - Madison Loop

Municipality	Block	Lot	Owner	Property Survey Access**	Easement Approval**	Date Executed
Old Bridge	5001	13.16	Manzo Old Bridge Properties, LLC	Acquired	Acquired	Acquired 1/30/18
Old Bridge	5000	4,18, 23 & 26	John Brunetti	Acquired	Pending	Pending
Old Bridge	4185	9.11	Harry Wilf, et al. (portions also Parkwood & Middlesex)	Acquired	Pending	Pending
Old Bridge	4185	9.15	Township of Old Bridge	Acquired	Pending	Pending
Old Bridge	4185	10	Parkwood Gardens Association/Madison	Acquired	Pending	Pending
Old Bridge	4185	4.11	Middlesex Builders, Inc.	Acquired	Pending	Pending
Old Bridge	4185	12.11 & 12.12	Basin Realty	Acquired	Pending	Pending
Old Bridge	4185	28.11	RDK, Inc.	Acquired	Pending	Pending

** Transco has received property access to all those parcels located along the Madison Loop and is working with the landowners to execute the necessary easement agreements. Per the above, some of the easements have been executed as this time and some are pending. The Northeast Supply Enhancement Project is a Federal Energy Regulatory Commission (FERC) 7C project and on March 27, 2017, Transco filed an application with the FERC requesting a Certificate of Public Convenience and Necessity (Certificate) under Section 7(c) of the Natural Gas Act (NGA). The Project has been assigned Docket No. CP17-101-000 b FERC. Upon receipt of an Order, Transco will be afforded rights to finalize the necessary easements required for the Project. Transco will keep NJDEP appraised of the reamining easement approvals as they are executed.

TABLE A.4 – SUMMARY OF PROJECT PERMITS

Northeast Supply Enhancement Project
Madison Loop
Federal, State, and Local Agency Permits and Approvals for the Project

Agency	Permits/Reviews	Project Component	Permit/Approval Anticipated/Actual Submission Date	Permit/ Approval Issuance Actual Receipt Date (Anticipated)
Federal				
Federal Energy Regulatory Commission	Certificate of Public Convenience and Necessity	All	Pre-filing initiated May 2016; formal application submitted on March 27, 2017	(November 2018)
U.S. Army Corps of Engineers	Section 404 Clean Water Act (CWA)/Section 10 Rivers and Harbors Act	All	Application for Madison Loop submitted June 27, 2017 and Supplemental Information to the application submitted September 15, 2017	(December 2018)
U.S. Fish and Wildlife Service, New Jersey and Pennsylvania Field Offices	Consultations for Section 7 Endangered Species Act Migratory Bird Treaty Act, Bald and Gold Eagle Protection Act, and Fish and Wildlife Coordination Act clearances	Madison Loop	Consultation initiated in June 2016. Draft Biological Assessment for Endangered Species Act-listed species submitted to Federal Energy Regulatory Commission (FERC) June 6, 2017.	(June 2018)
U.S. Environmental Protection Agency	CWA – National Pollutant Discharge Elimination System (NPDES)	All	See state requirements outlined below	12–18 months from submission date
	Clean Air Act - General Conformity	All	Submitted with FERC Application March 27, 2017	(September 2018)
New Jersey				
New Jersey Department of Environmental Protection (NJDEP) Coastal Management Program	Concurrence with Applicant's Coastal Zone Management Act (CZMA) Consistency Assessment	Madison Loop	Submitted July 7, 2017	(December 2018)
NJDEP Land Use Regulation Program	Waterfront Development Individual Permit	Madison Loop	Submitted July 7, 2017	(December 2018)
	Water Quality Certificate under Section 401 of the Federal CWA	Madison Loop	Concurrent with Waterfront Development Permit, Flood Hazard Area Permit, and Freshwater Wetlands Permit review	(December 2018)

Northeast Supply Enhancement Project
Madison Loop
Federal, State, and Local Agency Permits and Approvals for the Project

Agency	Permits/Reviews	Project Component	Permit/Approval Anticipated/Actual Submission Date	Permit/ Approval Issuance Actual Receipt Date (Anticipated)
	Release of Conservation Easement - Golden Age Property	Madison Loop	Consultation initiated in August 2017	(Q4 2018)
	Flood Hazard Area – Authorization, Individual Permit	Madison Loop	Submitted June 22, 2017	(December 2018)
	Freshwater Wetlands - Transition Area Waiver	Madison Loop	Submitted June 22, 2017	(December 2018)
	Freshwater Wetlands - Individual Permit	Madison Loop	Submitted June 22, 2017	(December 2018)
NJDEP Division of Water Quality, Bureau of Surface Water Permitting	Surface Water General Permit - Hydrostatic Test Water Discharges (DG)	Madison Loop	Application anticipated to be submitted in the 1st quarter of 2019	(Q1 2019)
NJDEP Division of Water Quality, Bureau of Surface Water Permitting	Short-term De Minimis Discharge Permit (B7)	Madison Loop	Application anticipated to be submitted in 1st quarter of 2019	(Q1 2019)
NJDEP Division of Water Quality, Bureau of Surface Water Permitting	NJPDES Discharge to Surface Water Permit will be the BGR – General Groundwater Remediation Cleanup Permit	Madison Loop	Application anticipated to be submitted in 2nd quarter of 2018	(Q3 2018)
NJDEP Division of Water Supply and Geoscience, Bureau of Water Allocation and Well Permitting	Temporary Dewatering Permit (BWA-002) – Old Bridge Township	Madison Loop	Application anticipated to be submitted in the 1st quarter of 2018	(Q3 2018)
NJDEP Division of Water Supply and Geoscience, Bureau of Water Allocation and Well Permitting	Temporary Dewatering Permit (BWA-002) - Sayreville Township	Madison Loop	Application anticipated to be submitted in the 1st quarter of 2018	(Q3 2018)

Northeast Supply Enhancement Project
Madison Loop
Federal, State, and Local Agency Permits and Approvals for the Project

Agency	Permits/Reviews	Project Component	Permit/Approval Anticipated/Actual Submission Date	Permit/ Approval Issuance Actual Receipt Date (Anticipated)
NJDEP Division of Water Supply and Geoscience, Bureau of Water Allocation and Well Permitting	Short-Term Water Use Permit-by-rule (BWA-003) – for hydrostatic testing activities	Madison Loop	Application anticipated to be submitted in 1st quarter of 2019	(Q1 2019)
NJDEP Division of Water Supply and Geoscience	Consultation for drinking water information	Madison Loop	Consultation initiated in August 2016	N/A
NJDEP Division of Water Quality, Bureau of Nonpoint Pollution Control	General Permit for Construction Activity, Storm Water (5G3)	Madison Loop	Application anticipated to be submitted in the 4th quarter of 2018	(Q4 2018)
NJDEP Division of Fish and Wildlife, Endangered and Nongame Species Program	Consultation for state-protected species	Madison Loop	Consultation initiated in May 2016	N/A
NJDEP Division of Parks and Forestry Natural Heritage Program	Consultation for presence of rare, threatened, and endangered species	Madison Loop	Consultation initiated in May 2016	N/A
NJDEP Division of Fish and Wildlife, Bureau of Freshwater Fisheries	Consultation for state freshwater fish habitat	Madison Loop	Consultation initiated in June 2016	N/A

Northeast Supply Enhancement Project
Madison Loop
Federal, State, and Local Agency Permits and Approvals for the Project

Agency	Permits/Reviews	Project Component	Permit/Approval Anticipated/Actual Submission Date	Permit/ Approval Issuance Actual Receipt Date (Anticipated)
	Section 106 NHPA cultural resources clearance/ Archeological Resources	Madison Loop	Onshore Phase I Archeological Survey for the Northeast Enhancement Project in Middlesex and Somerset Counties, New Jersey submitted February 7, 2017 Avoidance and Monitoring Plan for Site No. 28-MI-169 submitted May 1, 2017 Supplemental Phase I Archaeological Survey for the Northeast Supply Enhancement Project in Middlesex and Somerset Counties: Madison Loop Contractor Yard, Raritan Loop Cathodic Cable Route, changes to proposed CS 206 Access Road submitted on June 26, 2017.	Concurrence with Phase I survey results received March 30, 2017 Concurrence with avoidance and monitoring plan for Site No. 28-Mi-169 received June 8, 2017 Concurrence with supplemental Phase I results received July 28, 2017, included in Attachment 9c
	Section 106 NHPA cultural resources clearance/ Aboveground Resources	Madison Loop	Aboveground resources analysis (Architectural Investigations for the Northeast Supply Enhancement Project in Old Bridge Township and Borough of Sayreville, Middlesex County, and in Franklin Township, Somerset County, New Jersey) submitted February 28, 2017	Concurrence with results of aboveground resources analysis received March 22, 2017.
	Consultation with Native American Tribes	Delaware Tribe	All Cultural Resource Reports (PA, NY, and NJ)	Concurred on June 20, 2017
Local – New Jersey				
Freehold Soil Conservation District	E&S	Madison Loop	Submitted June 22, 2017	Certification received July 28, 2017

TABLE D.5 – PROPOSED DEWATERING LOCATIONS

Table D.5 (Old Bridge Township, BWA-002) - Northeast Supply Enhancement (NESE) Project

Station ID	EL (ft msl)	Municipality	State Well Permit No.	Location Description	Geological Formation	Length, ft	Excavation Depth, ft	Dewatering Anticipated?	Dewatering Rationale	Withdrawal Rate, gpm	Estimated Duration of Dewatering, days	Est. Max Withdrawal Rate (Mgal/mo)	Est. Max Withdrawal Rate (Mgal/yr)	Total Yield, Mgal	Total Yield, gal/ft
99 +23	90.5	Old Bridge	N/A	Trench	Pennsauken (Tb)	77	7	Yes	Perched water / wetland or stream	18.4	2	0.053	0.053	0.053	689
100 +00	93.3	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7	Yes	Perched water / wetland or stream	23.9	2	0.069	0.069	0.069	689
101 +00	92.0	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7	Yes	Perched water / wetland or stream	23.9	2	0.069	0.069	0.069	689
102 +00	93.3	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7	Yes	Perched water / wetland or stream	23.9	2	0.069	0.069	0.069	689
103 +00	92.1	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7	Yes	Perched water / wetland or stream	23.9	2	0.069	0.069	0.069	689
104 +00	83.5	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7	Yes	Perched water / wetland or stream	23.9	2	0.069	0.069	0.069	689
105 +00	79.5	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7	Yes	Perched water / wetland or stream	23.9	2	0.069	0.069	0.069	689
106 +00	81.5	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7	Yes	Perched water / wetland or stream	23.9	2	0.069	0.069	0.069	689
107 +00	75.3	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7	Yes	Perched water / wetland or stream	23.9	2	0.069	0.069	0.069	689
108 +00	69.3	Old Bridge	N/A	Trench	Magothy (K)	100	7	Yes	Perched water / wetland or stream	49.6	2	0.143	0.143	0.143	1428
109 +00	60.6	Old Bridge	N/A	Trench	Alluvium (Qal)	100	7	Yes	Perched water / wetland or stream	23.9	2	0.069	0.069	0.069	689
110 +00	61.0	Old Bridge	N/A	Trench	Alluvium (Qal)	100	7	Yes	Perched water / wetland or stream	23.9	2	0.069	0.069	0.069	689
111 +00	63.8	Old Bridge	N/A	Trench	Magothy (K)	100	7	Yes	Perched water / wetland or stream	49.6	2	0.143	0.143	0.143	1428
112 +00	64.1	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7	No	Pipe EL > GW Table, no perched water evidence	0.0	2	0.000	0.000	0.000	0
113 +00	68.9	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7	No	Pipe EL > GW Table, no perched water evidence	0.0	2	0.000	0.000	0.000	0
114 +00	72.0	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7	No	Pipe EL > GW Table, no perched water evidence	0.0	2	0.000	0.000	0.000	0
115 +00	72.4	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7	No	Pipe EL > GW Table, no perched water evidence	0.0	2	0.000	0.000	0.000	0
116 +00	72.2	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7	No	Pipe EL > GW Table, no perched water evidence	0.0	2	0.000	0.000	0.000	0
117 +00	84.8	Old Bridge	N/A	Trench	Pennsauken (Tb)	89	7	No	Pipe EL > GW Table, no perched water evidence	0.0	2	0.000	0.000	0.000	0
117 +89	84.8	Old Bridge	N/A	HDD Entry Pit	Pennsauken (Tb)	11	12	No	Pit EL > GW Table, no perched water evidence	0.0	7	0.000	0.000	0.000	0
118 +00	71.7	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
119 +00	79.5	Old Bridge	N/A	HDD	Magothy (K)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
120 +00	66.0	Old Bridge	N/A	HDD	Magothy (K)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
121 +00	65.0	Old Bridge	N/A	HDD	Alluvium (Qal)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
122 +00	62.7	Old Bridge	N/A	HDD	Alluvium (Qal)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
123 +00	61.9	Old Bridge	N/A	HDD	Alluvium (Qal)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
124 +00	66.2	Old Bridge	N/A	HDD	Magothy (K)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
125 +00	74.0	Old Bridge	N/A	HDD	Magothy (K)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
126 +00	73.1	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
127 +00	74.9	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
128 +00	81.4	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
129 +00	87.0	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
130 +00	83.8	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
131 +00	76.5	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
132 +00	74.3	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
133 +00	68.2	Old Bridge	N/A	HDD	Alluvium (Qal)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
134 +00	69.0	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
135 +00	72.3	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
136 +00	80.6	Old Bridge	N/A	HDD	Magothy (K)	89	---	No	HDD	0.0	0	0.000	0.000	0.000	0
136 +89	80.6	Old Bridge	N/A	HDD Exit Pit	Magothy (K)	11	12	No	Pit EL > GW Table, no perched water evidence	0.0	7	0.000	0.000	0.000	0
137 +00	83.2	Old Bridge	N/A	Trench	Magothy (K)	100	7	No	Pipe EL > GW Table, no perched water evidence	0.0	2	0.000	0.000	0.000	0
138 +00	86.5	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7	No	Pipe EL > GW Table, no perched water evidence	0.0	2	0.000	0.000	0.000	0
139 +00	83.2	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7	No	Pipe EL > GW Table, no perched water evidence	0.0	2	0.000	0.000	0.000	0
140 +00	91.2	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7	No	Pipe EL > GW Table, no perched water evidence	0.0	2	0.000	0.000	0.000	0
141 +00	96.0	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7	No	Pipe EL > GW Table, no perched water evidence	0.0	2	0.000	0.000	0.000	0
142 +00	89.4	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7	No	Pipe EL > GW Table, no perched water evidence	0.0	2	0.000	0.000	0.000	0
143 +00	88.2	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7	No	Pipe EL > GW Table, no perched water evidence	0.0	2	0.000	0.000	0.000	0
144 +00	87.9	Old Bridge	N/A	Trench	Pennsauken (Tb)	47	7	No	Pipe EL > GW Table, no perched water evidence	0.0	2	0.000	0.000	0.000	0
144 +47	87.0	Old Bridge	N/A	HDD Entry Pit	Pennsauken (Tb)	15	12	No	Pit EL > GW Table, no perched water evidence	0.0	7	0.000	0.000	0.000	0
144 +62	87.0	Old Bridge	N/A	HDD	Pennsauken (Tb)	38	---	No	HDD	0.0	0	0.000	0.000	0.000	0
145 +00	86.8	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
146 +00	85.2	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0

Table D.5 (Old Bridge Township, BWA-002) - Northeast Supply Enhancement (NESE) Project

Station ID	EL (ft msl)	Municipality	State Well Permit No.	Location Description	Geological Formation	Length, ft	Excavation Depth, ft	Dewatering Anticipated?	Dewatering Rationale	Withdrawal Rate, gpm	Estimated Duration of Dewatering, days	Est. Max Withdrawal Rate (Mgal/mo)	Est. Max Withdrawal Rate (Mgal/yr)	Total Yield, Mgal	Total Yield, gal/ft
147 +00	84.8	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
148 +00	86.7	Old Bridge	N/A	HDD	Magothy (K)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
149 +00	88.8	Old Bridge	N/A	HDD	Magothy (K)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
150 +00	95.6	Old Bridge	N/A	HDD	Magothy (K)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
151 +00	95.8	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
152 +00	98.2	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
153 +00	103.0	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
154 +00	107.0	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
155 +00	110.0	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
156 +00	113.0	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
157 +00	114.7	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
158 +00	116.0	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
159 +00	115.7	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
160 +00	116.6	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
161 +00	118.0	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
162 +00	121.0	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
163 +00	122.7	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
164 +00	123.0	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
165 +00	121.4	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
166 +00	111.9	Old Bridge	N/A	HDD	Magothy (K)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
167 +00	116.8	Old Bridge	N/A	HDD	Magothy (K)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
168 +00	119.4	Old Bridge	N/A	HDD	Magothy (K)	60	---	No	HDD	0.0	0	0.000	0.000	0.000	0
168 +60	121.0	Old Bridge	N/A	HDD Exit Pit	Magothy (K)	15	12	No	Pit EL > GW Table, no perched water evidence	0.0	7	0.000	0.000	0.000	0
168 +75	121.0	Old Bridge	N/A	Trench	Magothy (K)	25	7	No	Pipe EL > GW Table, no perched water evidence	0.0	2	0.000	0.000	0.000	0
169 +00	122.0	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7	No	Pipe EL > GW Table, no perched water evidence	0.0	2	0.000	0.000	0.000	0
170 +00	126.7	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7	No	Pipe EL > GW Table, no perched water evidence	0.0	2	0.000	0.000	0.000	0
171 +00	126.6	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7	No	Pipe EL > GW Table, no perched water evidence	0.0	2	0.000	0.000	0.000	0
172 +00	122.7	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7	No	Pipe EL > GW Table, no perched water evidence	0.0	2	0.000	0.000	0.000	0
173 +00	90.6	Old Bridge	N/A	Trench	Magothy (K)	100	7	No	Pipe EL > GW Table, no perched water evidence	0.0	2	0.000	0.000	0.000	0
174 +00	51.4	Old Bridge	N/A	Trench	Magothy (K)	100	7	No	Pipe EL > GW Table, no perched water evidence	0.0	2	0.000	0.000	0.000	0
175 +00	27.9	Old Bridge	N/A	Trench	Magothy (K)	100	7	Yes	Pipe EL < GW Table, or proximal to GW Table	49.6	2	0.143	0.143	0.143	1428
176 +00	21.1	Old Bridge	N/A	Trench	Magothy (K)	100	12	Yes	Pipe EL < GW Table, or proximal to GW Table	47.3	2	0.136	0.136	0.136	1362
177 +00	18.5	Old Bridge	N/A	Trench	Magothy (K)	100	7	Yes	Pipe EL < GW Table, or proximal to GW Table	49.6	2	0.143	0.143	0.143	1428
178 +00	17.7	Old Bridge	N/A	Trench	Magothy (K)	100	7	Yes	Pipe EL < GW Table, or proximal to GW Table	49.6	2	0.143	0.143	0.143	1428
179 +00	17.7	Old Bridge	N/A	Trench	Magothy (K)	100	7	Yes	Pipe EL < GW Table, or proximal to GW Table	49.6	2	0.143	0.143	0.143	1428
180 +00	19.7	Old Bridge	N/A	Trench	Magothy (K)	100	7	Yes	Pipe EL < GW Table, or proximal to GW Table	49.6	2	0.143	0.143	0.143	1428
181 +00	19.2	Old Bridge	N/A	Trench	Magothy (K)	100	7	Yes	Pipe EL < GW Table, or proximal to GW Table	49.6	2	0.143	0.143	0.143	1428
182 +00	18.1	Old Bridge	N/A	Trench	Magothy (K)	100	7	Yes	Pipe EL < GW Table, or proximal to GW Table	49.6	2	0.143	0.143	0.143	1428
183 +00	19.3	Old Bridge	N/A	Trench	Magothy (K)	100	7	Yes	Pipe EL < GW Table, or proximal to GW Table	49.6	2	0.143	0.143	0.143	1428
184 +00	19.3	Old Bridge	N/A	Trench	Magothy (K)	100	7	Yes	Pipe EL < GW Table, or proximal to GW Table	49.6	2	0.143	0.143	0.143	1428
185 +00	18.0	Old Bridge	N/A	Trench	Magothy (K)	100	7	Yes	Pipe EL < GW Table, or proximal to GW Table	49.6	2	0.143	0.143	0.143	1428
186 +00	18.1	Old Bridge	N/A	Trench	Magothy (K)	100	7	Yes	Pipe EL < GW Table, or proximal to GW Table	49.6	2	0.143	0.143	0.143	1428
187 +00	17.2	Old Bridge	N/A	Trench	Magothy (Kma)	100	7	Yes	Pipe EL < GW Table, or proximal to GW Table	13.5	2	0.039	0.039	0.039	388
188 +00	16.4	Old Bridge	N/A	Trench	Magothy (Kma)	100	7	Yes	Pipe EL < GW Table, or proximal to GW Table	13.5	2	0.039	0.039	0.039	388
189 +00	17.4	Old Bridge	N/A	Trench	Magothy (Kma)	100	12	Yes	Pipe EL < GW Table, or proximal to GW Table	12.0	2	0.035	0.035	0.035	347
190 +00	19.0	Old Bridge	N/A	Trench	Magothy (Kma)	100	7	Yes	Pipe EL < GW Table, or proximal to GW Table	13.5	2	0.039	0.039	0.039	388
191 +00	21.8	Old Bridge	N/A	Trench	Magothy (Kma)	100	7	Yes	Pipe EL < GW Table, or proximal to GW Table	13.5	2	0.039	0.039	0.039	388
192 +00	29.4	Old Bridge	N/A	Trench	Magothy (Kma)	100	7	Yes	Pipe EL < GW Table, or proximal to GW Table	13.5	2	0.039	0.039	0.039	388
193 +00	31.0	Old Bridge	N/A	Trench	Magothy (K)	30	7	No	Pipe EL > GW Table, no perched water evidence	0.0	2	0.000	0.000	0.000	0
193 +30	31.6	Old Bridge	N/A	Trench	Magothy (K)	0	7	No	Pipe EL > GW Table, no perched water evidence	0.0	0	0.000	0.000	0.000	0
					Total Length	9407					134			2.96	315

FIGURE E.1.A – PROPOSED DEWATERING WITHDRAWAL SOURCES

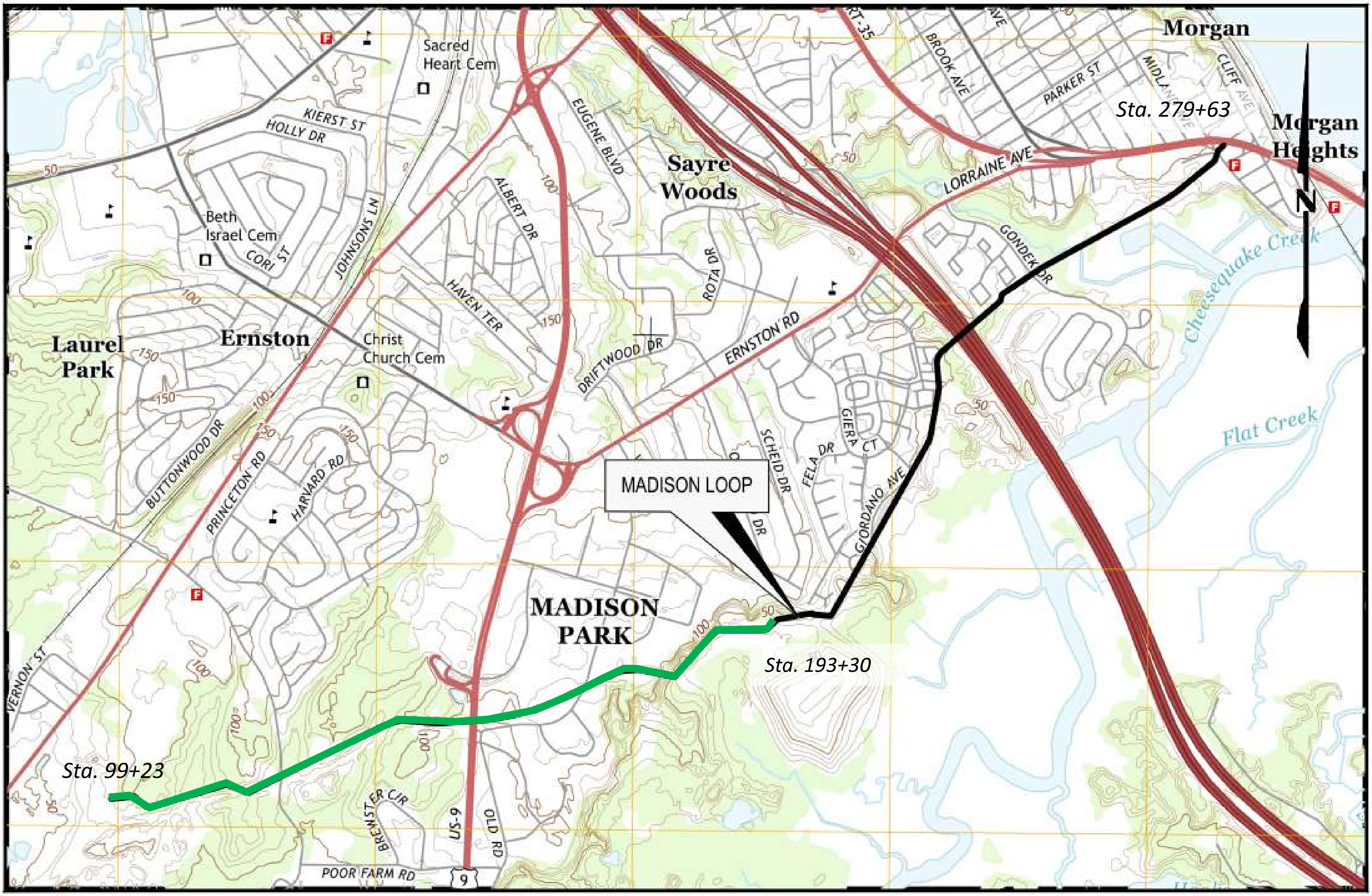
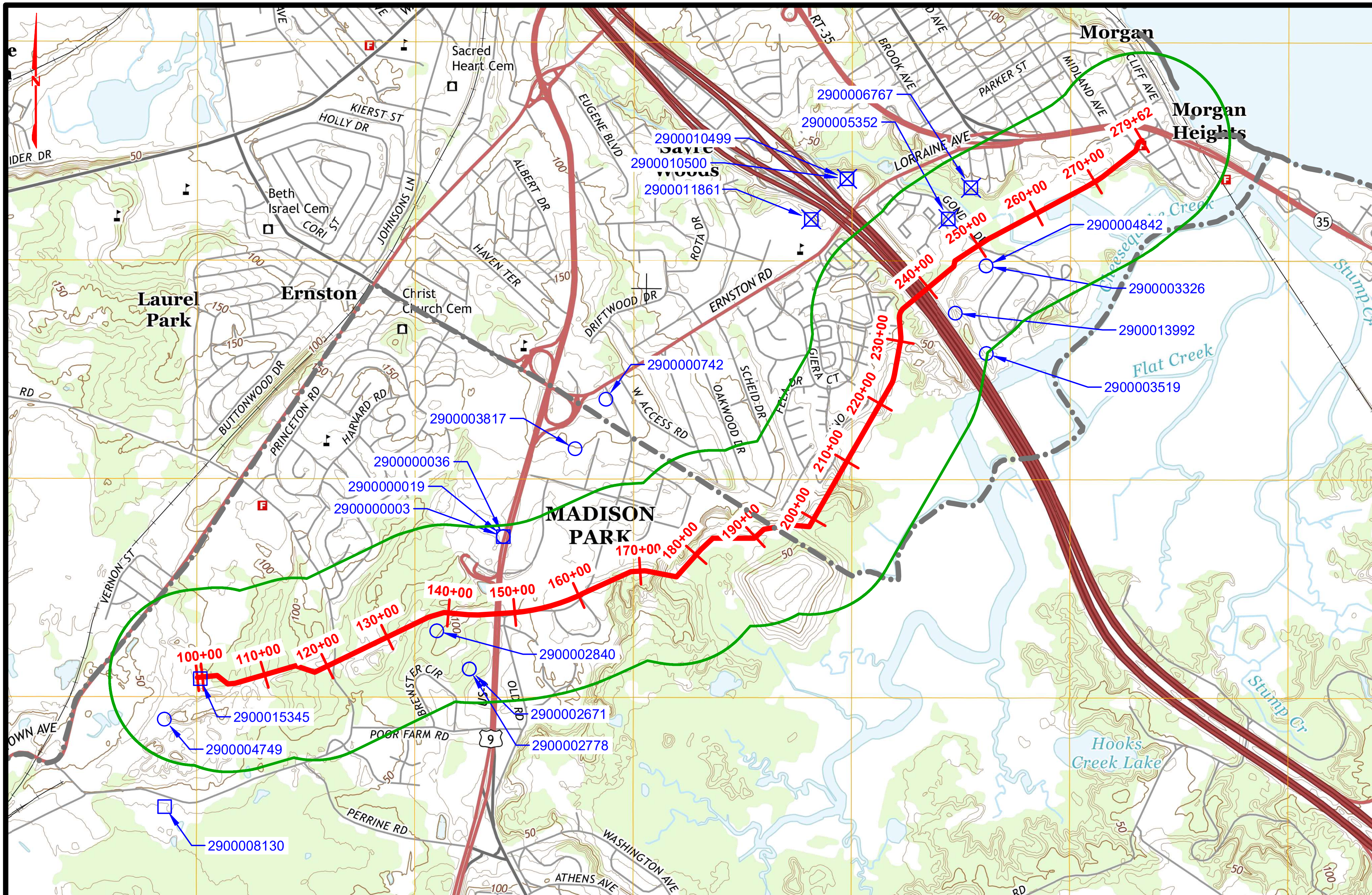


Figure E.1.a – USGS Map showing Proposed Dewatering Sources in Support of BWA-002 (Old Bridge Township) – Sta. 99+23 to Sta. 193+30 (see also Table D.5) Northeast Supply Enhancement Project (NESE) – Madison Loop

Old Bridge Township portion of Madison Loop (Sta. 99+23 to Sta. 193+30)

FIGURE E.1.B – WATER SUPPLY WELLS IN ¼ MILE RADIUS



- MADISON LOOP
- 1/4 MILE BUFFER
- TOWNSHIP / BOROUGH BOUNDARY
- DOMESTIC WELLS
- INDUSTRIAL WELLS
- PUBLIC COMMUNITY WELLS

NOTES:
1. USGS MAP FROM 7.5' QUADRANGLE, SOUTH AMBOY, NJ-NY 2014..

2,000' 1,000' 0' 2,000'

SCALE: 1" = 2,000'

AECOM
625 WEST RIDGE PIKE, SUITE E-100
CONSHOHOCKEN, PA 19428
(610) 832-3500

REVISIONS

NO.	DATE	BY	DESCRIPTION	W.O. NO.	CHK.	APP.

TRANSCONTINENTAL GAS PIPE LINE COMPANY, LLC.
NORTHEAST SUPPLY ENHANCEMENT PROJECT
PROPOSED 26" MADISON LOOP
FIGURE E-1..b
WELL SEARCH MAP
MIDDLESEX COUNTY, NEW JERSEY

Williams GAS PIPELINE

DRAWN BY: PPH	DATE: 02/26/2018	ISSUED FOR BID: TBD		SCALE: 1" = 1,000'	
CHECKED BY: MO	DATE: 02/26/2018	ISSUED FOR CONSTRUCTION: TBD		REVISION: 0	
APPROVED BY: HB	DATE: 02/26/2018	DRAWING NUMBER:		SHEET 1 OF 1	
WO:					

Drawn By & Date/Time: haasp Feb 27, 2018 – 2:53pm
Drawing Location & Name: C:\Project Files\Williams\Madison\Dewatering\00 – Madison Dewatering_Figure 6.dwg

FIGURE E.1.C – LANDFILLS AND GROUNDWATER CONTAMINATION IN ¼ MILE RADIUS

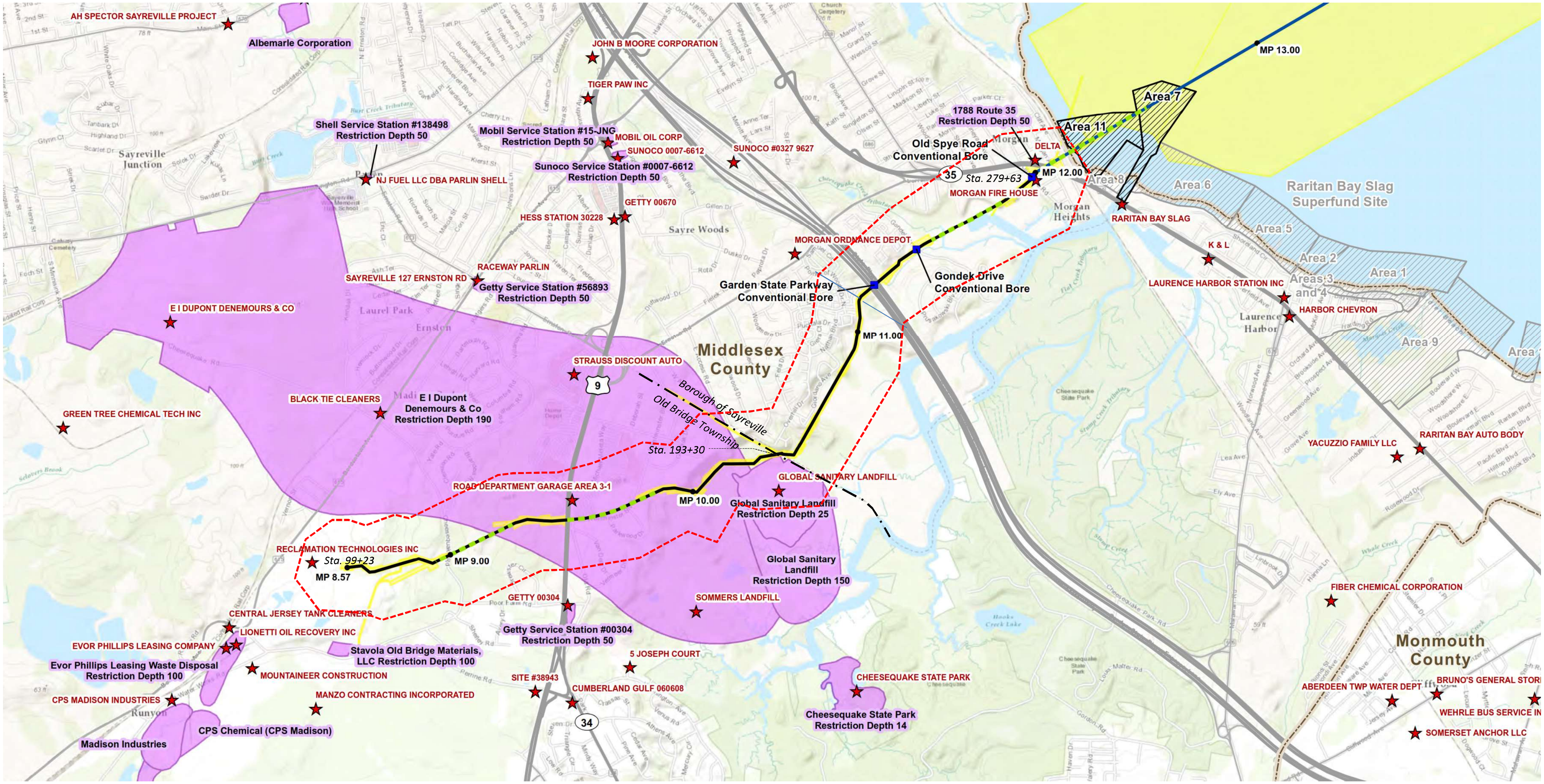


Figure E.1.c - Contamination Sites within ¼-mile Radius in Support of BWA-002 (Old Bridge Township) Northeast Supply Enhancement Project (NESE)

¼-mile radius corridor from Sta. 99+23 to Sta. 279+63

NJDEP Classification Exception Area (CEA)

NJDEP Known Contaminated Site

Figure adapted from Williams Figure 2A-5 (dated 3/22/2017)

TABLE E.2.A – WELL SUMMARY TABLE

Table E.2.A - Water Supply Wells in 1/4-Mile Radius

Northeast Supply Enhancement (NESE) - Madison Loop (Old Bridge Township)

NJDEP Doc ID	Activity_ID	Municipality	Loc_Type	Owner**	Well_Type	Permit_No	Local Well ID	Status	Depth, ft	X_Coord (ft)	Y_Coord (ft)	Distance from edge of workspace, ft	Diversion ID
3788094	WPN470003	Old Bridge	Well	ROUTE NINE PLAZA LLC	Domestic	2900000003			100	547,898	588,228	1,089	WSWL_746083
14747860	WAR110036	Old Bridge	Well	ROUTE NINE PLAZA LLC	Domestic	2900000019	#1	Active	132	547,898	588,228	1,089	WSWL_746099
3788203	WPN490001	Old Bridge	Well	ROUTE NINE PLAZA LLC	Industrial	2900000036			203	547,898	588,228	1,089	WSWL_746114
14700026	WAR110012	Old Bridge	Well	FLOREK FAMILY TRUST	Domestic	2900002671	1	Active	184	547,387	586,236	713	WSWL_720286
14700161	WAR110013	Old Bridge	Well	FLOREK FAMILY TRUST	Domestic	2900002778	1	Active	196	547,387	586,236	713	WSWL_720390
3698542	WPN590002	Old Bridge	Well	BRUNETTI, JOHN	Domestic	2900002840			80	546,896	586,809	125	WSWL_720452
14722992	WAR110042	Old Bridge	Well	OLD BRIDGE FEE OWNER LLC	Domestic	2900003817		Active	195	548,977	589,546	2,221	WSWL_703250
3596563	WPN650091	Old Bridge	Well	RECLAMATION TECH % VIP HONDA INC	Domestic	2900004749			114	542,801	585,485	780	WSWL_692141
14722947	WAR112320	Old Bridge	Well	OLD BRIDGE-WATER WORKS REALTY LLC	Industrial	2900008130	#1	Active	68	542,804	584,169	1,956	WSWL_66336
14814698	WAR110174	Old Bridge	Well	TRANSCONTNTL GAS PIPE LINE MD 46-4	Industrial	2900015345		Active	117	543,341	586,093	0	WSWL_552722

Column titles (2nd row) in gray are the original field names of the shape file received from NJDEP on February 20, 2018.
The original shape file (as received on February 20, 2018) was edited in order to remove obvious duplicate entries.
The true field locations of these wells were not verified independently, either by AECOM or Transco.
Figure E.1.B shows the locations (based on the X- and Y-coordinate fields) in relation to the linear extent of the Project, with each well labeled by its reported permit number.
The listing is sorted by well permit number.
*** Well Owner data is not provided within the NJDEP well data requested. This information has been populated for the NJDEP GeoWeb block/lot data layer.*

TABLE E.2.B – SUMMARY OF LANDFILLS AND GROUNDWATER CONTAMINATION IN ¼ MILE RADIUS

Table E.2.b

Sites with Confirmed Contamination within a 1/4-mile radius of Northeast Supply Enhancement (NESE) Project - Madison Loop

Site Name	Municipality	Source	Distance from Pipeline	Direction from Pipeline	Position of Pipeline Relative to Identified Site	Geological Fm. Impacted	Site Status	Site ID No.
			miles					
Reclamations Technologies Inc.	Old Bridge	NJDEP DataMiner and GeoWeb	>0.1	West	Upgradient	Magothy Fm.	active	NJDEP Site Remediation Program PI ID #129931
Road Department Garage Area 3-1	Old Bridge	NJ Release, NJ Brownfields	<0.1	North	Downgradient	Pennsauken Fm., Magothy Fm.	active	NJDEP Site Remediation Program PI ID #012743
Global Sanitary Landfill Superfund Site	Old Bridge	NPL	<0.1	South	Upgradient	Magothy Fm.	active	EPA ID #NJD063160667
Global Sanitary Landfill CEA	Old Bridge	NJDEP DataMiner and Geoweb	<0.1	South	Downgradient	Magothy Fm.	active	EPA ID #NJD063160667
E I Dupont Nemours Co. CEA	Old Bridge	NJDEO DataMiner and Geoweb	<0.1	North and South	Upgradient and Downgradient	Magothy Fm.	active	NJDEP Site Remediation Program PI ID #008222
1788 Route 35 in Sayreville, NJ	Sayreville	SHWS/HIST HWS, New Jersey Release, New Jersey Spill	<0.1	Northeast	Downgradient	Magothy Fm.	active	NJDEP Site Remediation Program PI ID #026234
Morgan Fire House*	Sayreville	SHWS/HIST HWS, New Jersey Release	<0.1	South	Upgradient	Magothy Fm.	inactive	NJDEP Site Remediation Program PI ID #003720

FUDS – Formerly Used Defense Sites. The Department of Defense is responsible for the environmental restoration of properties that were formerly owned by, leased to, or otherwise possessed by the United States and are under the jurisdiction of the Secretary of Defense prior to October 1986.

New Jersey Brownfields – Brownfields sites are identified as former or current commercial or industrial use sites that are presently vacant or underutilized on which there is suspected to have been a discharge of contamination to the soil or groundwater at concentrations greater than the applicable cleanup criteria.

New Jersey Release – New Jersey Hazardous Material Release database is a record of the initial notification information reported to the NJDEP's Action Line.

New Jersey Spill – All HazMat known or unknown spills to the ground reported to the NJ DEP's Action Line.

NPL – National Priority List database, also known as Superfund, is a subset of Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) and identifies over 1,200 sites for priority cleanup under the Superfund program. The source of this database is the United States Environmental Protection Agency.

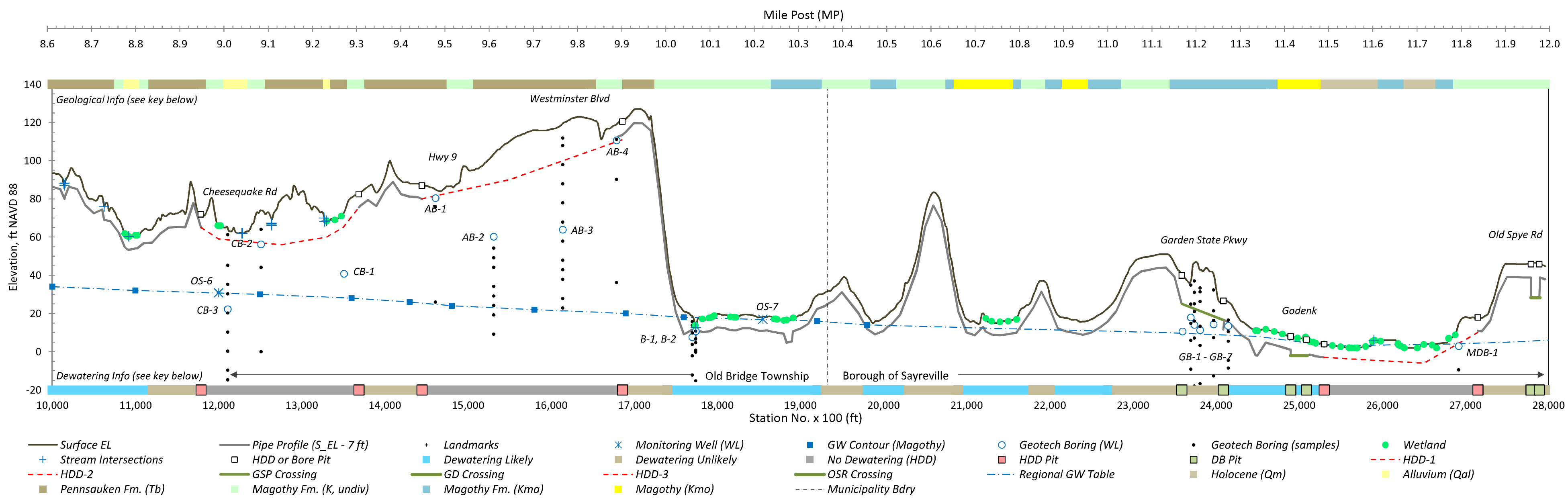
SHWS/HIST HWS - State Hazardous Waste Sites/Historic Hazardous Waste Sites – Known Contaminated Sites in New Jersey database is a municipal listing of sites where contamination of soil and/or groundwater is confirmed at levels greater than the applicable cleanup criteria or standards. Remedial activities are under way or required at the sites with an on-site source(s) of contamination and at locations where the source(s) of contamination are unknown. Sites with completed remedial work that require engineering and/or institutional controls have reporting measures in place to ensure the effectiveness of past actions, and some include maintenance and/or monitoring.

** The Morgan Fire House is listed on both the NJDEP Active Sites with Confirmed Contamination list and the NJDEP Closed Sites with Remediated Contamination list. The site is included on the Known Contaminated Site list but is classified as no further action (restricted use) with an active deed notice in the NJDEP post-remediation group.*

FIGURE F.1 – GROUNDWATER DEPTH IN FEET OVER SITE

Figure F.1

Northeast Supply Enhancement (NESE) Project - Old Bridge Township (BWA-002)



SECTION 2

TECHNICAL REPORT

Prepared for:
Transcontinental Gas Pipe Line Company
Houston, TX

Prepared by:
AECOM
Conshohocken, PA

March 2018

Construction Dewatering Assessment Technical Report

Transcontinental Gas Pipe Line Company, LLC
Northeast Supply Enhancement Project – Madison Loop

Old Bridge Township
Middlesex County, New Jersey

March 2018

Prepared for:
Transcontinental Gas Pipe Line Company
Houston, TX

Prepared by:
AECOM
Conshohocken, PA

March 2018

Construction Dewatering Assessment Technical Report

Transcontinental Gas Pipe Line Company, LLC
Northeast Supply Enhancement Project – Madison Loop

Old Bridge Township
Middlesex County, New Jersey

Matthias Ohr

____
Prepared By: Matthias Ohr, AECOM

Heather Brewster

____
Reviewed By: Heather Brewster, AECOM

Table of Contents

1.0 Introduction 1-1

1.1 Project Description 1-1

1.2 Scope and Objectives 1-2

1.3 Public Interest 1-3

1.4 Summary of Previous Investigations 1-4

1.4.1 Geotechnical Investigation 1-4

1.4.2 Review of Hazardous Waste or Known Contaminated Sites 1-4

2.0 Geological and Hydrogeological Setting 2-1

2.1 Regional Geology and Soil Classification 2-1

2.1.1 Subsurface Geology 2-1

2.1.2 Surface Geology 2-2

2.2 Site Setting and Land Use 2-3

2.3 Site Hydrology 2-3

2.3.1 Surface Water and Wetlands 2-3

2.3.2 Groundwater-Bearing Units at the Project Site 2-5

3.0 Project Dewatering 3-1

3.1 Construction Overview and Decision Criteria 3-1

3.2 Construction Dewatering 3-2

3.2.1 Overview 3-2

3.2.2 Estimating the Radius of Influence 3-2

3.2.3 Open Cut Trenches 3-3

3.2.4 Other Excavations 3-3

3.2.5 Uncertainties 3-4

3.2.6 **Limitations** 3-6

3.2.7 Estimated Dewatering Discharge Rates 3-6

3.2.8 Anticipated Methods of Dewatering 3-7

4.0 Environmental Impact 4-1

4.1 Potential Impacts to Groundwater Supply and Nearby Groundwater Users 4-1

4.2 Potential for Spreading Groundwater Contamination 4-1

4.3 Potential Impacts to Wetlands and Waterbodies 4-1

4.4 Potential for Salt Water Intrusion 4-2

5.0 References 5-1

List of Appendices

Appendix A	Geotechnical Investigation Reports
Appendix B	Dewatering Calculation Details

List of Tables

Table 1	Summary of Linear Project
Table 2	Sites with Confirmed Contamination with ¼-mile Radius of the NESE Project – Madison Loop
Table 3	¼-mile Well Search Results
Table 4	Summary of Geotechnical Testing and Estimated Permeability
Table 5	Estimated Dewatering Rates along Project Extent

List of Figures

Figure 1	USGS Topographic Quadrangle
Figure 2	Project Location Map – USGS, Aerial, Surficial Geology and Bedrock Geology
Figure 3	Hazardous Waste and Known Contaminated Sites
Figure 4	Topography and Hydrogeolocial Project Profile
Figure 5	Regional Groundwater Elevation Contour Map
Figure 6	Well Search Map

List of Acronyms

ASTM	American Society of Testing Materials
Certificate	Certificate of Public Convenience and Necessity
cm/sec	centimeter per second
CEA	Classification Exception Area
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CP	cathodic protection
dth/d	dekatherms per day
Δh	drawdown, $H-h_w$
EDR	Environmental Data Resources, Inc.
FERC	Federal Energy Regulatory Commission
ft/day	feet per day
ft bgs	feet below ground surface
ft msl	elevation in feet relative to mean sea level (NAVD 88)
gpm	gallons per minute
H	saturated thickness, static
h_w	saturated thickness, when pumping
HDD	horizontal directional drill
hp	horsepower
i	hydraulic gradient
K	hydraulic conductivity
LNYBL	Lower New York Bay Lateral
M&R	metering and regulating
μm/sec	micrometer per second
m/day	meter per day
Mgm	million gallons per month
Mgy	million gallons per year
MP	milepost
NAVFAC	Navy Facilities Engineering Command
NESE	Northeast Supply Enhancement
NJ	New Jersey
NJGS	New Jersey Geological Survey
NJ KCS	New Jersey Known Contaminated Sites
NJN	New Jersey Natural Gas Company
NJ Releases	NJ Hazardous Materials Incident Database
NJDEP	New Jersey Department of Environmental Protection
NPL	National Priority List
RCRA-CORRACTS	Resource Conservation and Recovery Act – Corrective Action Sites
RCRA NonGen	Resource Conservation Recovery Act Non-Generator
RDL	Rockaway Delivery Lateral
R(o)	radius of Influence
ROW	right-of-way
SHWS	NJ Known Contaminated Sites List
Transco	Transcontinental Gas Pipe Line Company, LLC
TSD	treatment, storage and disposal
USCS	United Soil Classification System
VOCs	Volatile Organic Constituents
WRA	Well Restriction Area

Executive Summary

This technical report was prepared in support of the application package for a temporary dewatering permit BWA-002 for the Madison Loop project (the Project), located in the Borough of Sayreville and Old Bridge Township as part of Transcontinental Gas Pipe Line Company, LLC (Transco), a wholly-owned subsidiary of Williams Partners L.P., Northeast Supply Enhancement (NESE) Project. The technical report was prepared in accordance with the permit application requirements and includes the following sections:

- **Section 1** includes the Project description, a discussion regarding the public interest, and a summary of previous investigations;
- **Section 2** provides a discussion of the local geologic and hydrogeologic conditions of the Project;
- **Section 3** presents the methodology employed and the results of estimating the anticipated dewatering rates and yield for the trenching activities of the Project. The stated duration and depths of line trench excavations are based on the currently anticipated construction details for the Project.
- **Section 4** discusses the potential for impacts to local groundwater resources and environmental impacts; and
- **Section 5** provides the references used in the technical report.

Conceptually, the following approach was taken to estimate dewatering rates, and therefore to estimate the anticipated diversion limits (in Mgal/month) and linear yield (gal/ft) for the Project:

- The Project was subdivided into 100-ft segments and each segment was analyzed in terms of its proposed construction activities, the prevailing geological and hydrogeological conditions, and the potential that construction dewatering will be required. **Tables 1** and **5** provide the details of this analysis, which in turn is visualized as a topographic and hydrogeological profile shown as **Figure 4**.
- Construction elements that were anticipated to require dewatering included open cut trenches and the launch / exit pits for direct bores and horizontal directional drilling (HDD). The HDD segments itself were not considered.
- If the base of the excavation of a specific segment was determined to be near or below the ambient water table, or in the vicinity of perched water table conditions or hydric soils, the segment was included in the estimation of the diversion. Conversely, if the base of the excavation of a specific segment was determined to be well above the ambient water table, or at a distance from perched water table or other hydric conditions, the segment was not included.
- The dewatering rate (per 100-ft segment) was estimated from available geotechnical and geological information (such as grain size curves or soil types) and standard dewatering equations for line sources and excavations (e.g., Dupuit-Forchtheimer equation), as summarized in **Appendix B**.
- Once the dewatering rate was estimated (in gpm/100 ft), the overall estimated yield was calculated using an estimate of the duration of construction along each segment.
- Adding up these total (incremental) yield estimates (for those segments that were determined to require potential dewatering) resulted in the total estimated yield for the Project. (see **Table 5**)
- The linear yield (in gal per ft) was then calculated from the total estimated yield divided by the total length of the Project. (see **Table 5**)
- Based on these calculations, as summarized in **Table 5** (which corresponds to **Table D.5** of the permit application form), the following diversion and yield quantities were entered into permit application form:
  - Section D.2 - Requested Allocation (Mgm): = 2-times the cumulative estimated dewatering yield for the Project (the factor 2 was introduced to provide a margin of conservatism);
  - Section D.2 – Maximum diversion Rate (gpm): = estimated maximum pumping capacity that may be deployed to the Project;
  - Section F.5 – Average diversion (gal/ft) per foot of open trench = estimated total yield divided by the length of the actively dewatered trench segments (i.e., not divided by the total length of the project).

1.0 Introduction

1.1 Project Description

Transcontinental Gas Pipe Line Company, LLC (Transco), a wholly-owned subsidiary of Williams Partners L.P., is developing its Northeast Supply Enhancement (NESE) Project (Project) to support National Grid's long-term growth, reliability, and flexibility beginning in the 2019/2020 heating season. Transco is proposing to expand its existing interstate natural gas pipeline system in Pennsylvania and New Jersey and its existing offshore natural gas pipeline system in New Jersey and New York waters. The Project capacity is fully subscribed by two entities of National Grid: Brooklyn Union Gas Company (d/b/a [doing business as] National Grid NY) and KeySpan Gas East Corporation (d/b/a National Grid), collectively referred to herein as "National Grid."

To provide the incremental 400,000 dekatherms per day (Dth/d) of capacity, Transco plans to expand portions of its system from the existing Compressor Station 195 in York County, Pennsylvania, to the Rockaway Transfer Point in New York State waters. As defined in executed precedent agreements with National Grid, the Rockaway Transfer Point is the interconnection point between Transco's existing Lower New York Bay Lateral (LNYBL) and existing offshore Rockaway Delivery Lateral (RDL).

A description of the entirety of the Project facilities is provided below. The project elements that are subject to this Technical Report are highlighted in **bold** with an asterisk (*). Note that the mileposts (MPs) provided below for the onshore pipeline facilities correspond to the existing Transco Mainline and Lower New York Bay Lateral. The offshore pipeline facility MPs are unique to the Raritan Bay Loop. The starting MP for the Raritan Bay Loop corresponds to MP12.00 of the Lower New York Bay Lateral, and the end MP corresponds to the Rockaway Transfer Point.

Onshore Pipeline Facilities

Quarryville Loop

- 10.17 miles of 42-inch-diameter pipeline from MP1681.00 near Compressor Station 195 to MP1691.17 co-located with the Transco Mainline in Drumore, East Drumore, and Eden Townships, Lancaster County, Pennsylvania. Once in service, the Quarryville Loop will be referred to as Mainline D.

Madison Loop *

- 3.43 miles of 26-inch-diameter pipeline from Compressor Station 207 at MP8.57 to MP12.00 southwest of the Morgan meter and regulating (M&R) Station on the Lower New York Bay Lateral Loop C in Old Bridge Township and the Borough of Sayreville, Middlesex County, New Jersey. Once in service, the Madison Loop will be referred to as Lower New York Bay Lateral Loop F.

Raritan Bay Loop

- 0.16 mile of 26-inch-diameter pipeline from MP12.00 west-southwest of the Morgan M&R Station to the Sayreville shoreline at MP12.16. Additionally, a cathodic protection (CP) power cable will be installed from a rectifier located at the existing Transco Morgan M&R Station near MP12.10 and extending to a connecting point on the proposed 26-inch-diameter pipeline at MP12.00. The approximately 545-foot-long power cable will be installed by horizontal directional drill (HDD).

Offshore Pipeline Facilities

Raritan Bay Loop

- 23.33 miles of 26-inch-diameter pipeline from MP12.16 at the Sayreville shoreline in Middlesex County, New Jersey, to MP35.49 at the Rockaway Transfer Point in the Lower New York Bay, New York, south of the Rockaway Peninsula in Queens County, New York. Additionally, a 1,831-foot-long CP power cable will be installed via HDD from a rectifier at the existing Transco Morgan M&R Station near MP12.10 to an offshore anode sled located approximately 1,200 feet north of

MP12.32. Once in service, the Raritan Bay Loop will be referred to as Lower New York Bay Lateral Loop F.

Aboveground Facilities

New Compressor Station 206

- Construction of a new 32,000 ISO (International Organization for Standardization) horsepower (hp) compressor station and related ancillary equipment in Franklin Township, Somerset County, New Jersey, with two Solar Mars® 100 (or equivalent) natural gas-fired, turbine-driven compressors.

Modifications to Existing Compressor Station 200

- Addition of one electric motor-driven compressor (21,902 hp) and related ancillary equipment to Transco's existing Compressor Station 200 in East Whiteland Township, Chester County, Pennsylvania.

Modifications to Existing Mainline Valve Facilities

- *Existing Valve Site 195-5* – Installation of a new mainline valve, launcher/receiver and tie-in facilities at the start of the Quarryville Loop (MP1681.00).
- *Existing Valve Site 195-10* – Installation of a new mainline valve, launcher/receiver, and tie-in facilities at the end of the Quarryville Loop (MP1691.17).
- *Existing Valve Site 200-55* – Installation of a new mainline valve, launcher/receiver, and tie-in facilities at the start of the Madison Loop (MP8.57).

New Mainline Valve Facilities

- *Proposed Valve Site 195-8* – Installation of a new intermediate mainline valve for the Quarryville Loop (MP1687.86).
- ***Proposed Valve Site 200-59*** * – Installation of a new mainline (isolation) valve for the Madison Loop (MP11.90).

On March 27, 2017, Transco filed an application with the Federal Energy Regulatory Commission (FERC) requesting a Certificate of Public Convenience and Necessity (Certificate) under Section 7(c) of the Natural Gas Act (NGA). The Project has been assigned Docket No. CP17-101-000 b FERC.

This Technical Report is focused on the construction activities occurring on the Madison Loop pipeline facilities in Old Bridge Township, Middlesex County, New Jersey. The modifications to Valve Site 200-55 at the existing Compressor Station 207 will not require dewatering.

1.2 Scope and Objectives

The construction of the Madison Loop pipeline facilities in Old Bridge Township is expected to require excavation dewatering along certain segments of the Project. The overall location of the project is shown on **Figure 1** (USGS quadrangle map) and **Figure 2**. The segments of the Project that will likely require dewatering (based on the analysis presented in this report) are shown in **Figure 4** (project profile).

AECOM, on behalf of Transco, has prepared this technical report in support of its temporary dewatering permit application for trench dewatering activities in Old Bridge Township. The purpose of this report is to provide the necessary hydrogeological information to support the Application Requirements for a Temporary Dewatering Permit in accordance with N.J.A.C. 7:19-2.3. For cross-reference, the presentation elements of this Technical Report correspond to those included within the Temporary Dewatering Permit application as follows:

This Report	Temp Dewatering Permit Application	Description
Table 1	Portion of Table D.5	Summary of project elements
Table 2	Table E.2.b	Hazardous waste and known contaminated sites
Table 3	Table E.1.b	Supply Wells within ¼-mile radius of Project
Table 4	---	Summary of geotechnical testing results
Table 5	Portion of Table D.5	Estimated dewatering rates and linear yield
----------	----------	----------
Figure 1	Figure E.1.a	USGS quadrangle map
Figure 2	----	Project extent and aerial and geological overlay maps
Figure 3	Figure E.1.c	Hazardous waste and known contaminated sites
Figure 4	Figure F.1	Topographic and hydrogeological profile
Figure 5	---	Regional groundwater elevation contours
Figure 6	Figure E.1.b	Well search map

This technical report is organized as follows:

- Section 1 includes the Project description, a discussion regarding the public interest, and a summary of previous investigations;
- Section 2 provides a discussion of the local geologic and hydrogeologic conditions of the Project;
- Section 3 presents the methodology employed and the results of estimating the anticipated dewatering rates and yield for the trenching activities of the Project. The stated duration and depths of line trench excavations are based on the currently anticipated construction details for the Madison Loop.
- Section 4 discusses the potential for impacts to local groundwater resources and environmental impacts; and
- Section 5 provides the references used in the technical report.

1.3 Public Interest

As introduced above, the Project proposes to construct, install, and operate the Project facilities to provide 400,000 Dth/d of incremental firm transportation capacity to National Grid from Compressor Station 195 through the Rockaway Transfer Point to supply National Grid's existing service territory beginning in the 2019/2020 heating season, when the incremental supply will be needed.

Transco's existing natural gas transportation system currently supplies natural gas to the New York City metropolitan region via National Grid's existing receipt points. Transco's New York Bay Expansion project, which has been certificated and is currently under construction, will provide National Grid with 50,000 Dth/d at the Narrows meter station and 65,000 Dth/d at the Rockaway Transfer Point to satisfy upcoming supply needs for the 2017/2018 heating season. However, National Grid is experiencing incremental firm demand and anticipating system growth beyond the 2017/2018 heating season. Therefore, subsequent incremental supplies are needed beginning in the 2019/2020 heating season that will be provided through the NESE Project.

Transco has executed long-term, fully binding precedent agreements with National Grid for 100% of the Project capacity. Transco held an open season for the Project from May 16, 2016, to June 9, 2016, to allow other shippers to receive service under the Project, but no other shippers participated in the Binding Open Season. Therefore, National Grid will utilize 100% of the Project's capacity. National Grid's precedent agreement describes its intention to utilize the capacity provided by the Project to serve its retail customers across its existing service territory.

In order to construct the facilities, it is anticipated that excavation dewatering of certain segments of the construction will be necessary (e.g., line trenching to install the pipeline facilities).

1.4 Summary of Previous Investigations

Previous site investigation activities have involved the completion of limited geotechnical testing along the Project. In addition, a review of potential hazardous waste and/or NJ known contaminated sites in the vicinity of the Project was conducted in the conjunction with the March 2017 filing of the Certificate application with FERC. A summary of each of these investigations is provided below.

1.4.1 Geotechnical Investigation

AECOM, on behalf Transco, conducted several geotechnical investigation of the Project between September 2016 and August 2017. The geotechnical reports specific to the Project are presented as **Appendix A** to this technical report. The investigation locations are shown in **Figure 2** and included the following components (locations in Old Bridge Township are marked with an asterisk [*] and in **bold**):

- Installation and logging of seventeen (17) test borings, as follows:
  - * 3 borings (**CB-1** through **CB-3**) between Station No. 121+10 and Station No. 135+10;
  - * 4 borings (**AB-1** through **AB-4**) between Station No. 146+10 and Station No. 167+90;
  - * 2 borings (**B-1** and **B-2**) between Station No. 177+00 and Station No. 177+90;
  - 6 borings (GB-1 through GB-7) between Station No. 235+97 and Station No. 241+47; and
  - 2 borings (MDB-1 and MB-1) between Station No. 269+20 and Station 275+00.

- Sample collection from representative soil intervals and analysis for the following parameters: natural water content, grain size distribution, Atterberg Limits, and specific gravity. In addition, triaxial compression tests and consolidation tests were performed on undisturbed samples.

The data obtained during the geotechnical investigation in the context of deriving estimated dewatering rates and dewatering yields is further discussed in **Section 2.1.2**.

1.4.2 Review of Hazardous Waste or Known Contaminated Sites

In order to identify landfills, hazardous waste sites or other known contaminated sites (KCS) in the vicinity of the Project area, a hazardous material environmental data search was conducted for the proposed onshore pipeline facilities and the new aboveground facilities in Pennsylvania and New Jersey. This search was performed according to the government records search requirements of the American Society of Testing Materials (ASTM) Standard Practice for Environmental Site Assessments, E 1527-13. The objective of the database searches was to identify sites of known environmental or regulatory concern that are located within 0.25 mile of the construction work areas. The detailed output of the database searches, as conducted by Environmental Data Resources, Inc. (EDR), are available upon request, and were filed previously with the FERC Certificate submittals. **Table 2** provides a summary of the information shown below.

The database search covered Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Superfund Sites, National Priority List (NPL) Sites, Resource Conservation and Recovery Act – Corrective Action (RCRA-CORRACTS) facilities, RCRA treatment, storage and disposal (TSD) Facilities, RCRA Generators, Leaking Underground Storage Tank Sites, and State Spill Sites that may have the potential to impact soils, groundwater, surface streams or sediments.

Within the Old Bridge Township, the EDR Datamap™ Corridor Study for the Madison Loop (EDR 2016c) identified two (2) active sites with confirmed contamination and two (2) NJDEP Classification Exception Areas (CEA) within 0.25-mile of the Madison Loop. In addition, the NJDEP database of KCS was reviewed and resulted in one (1) additional active site of potential concern that was not otherwise identified in the EDR search. These sites have reported contamination that have the potential to impact groundwater quality in the vicinity of the Project facilities.

Reclamation Technologies Inc.: The NJDEP database search of KCS returned site remediation program (SRP) ID 129931, located at 3200 Bordentown Avenue, Old Bridge, NJ with the status indicated as active. The SRP case tracking tool indicates the Site to be in multi-phase remedial action, with discharges to both groundwater and soil.

Road Department Garage Area 3-1: The New Jersey Open Public Records Act (OPRA) database indicates that the Middlesex County Road Department Garage Area 3-1 is located along Route 9 North in Old Bridge Township, New Jersey, less than 0.1 mile north of MP9.50 of the Madison Loop (NJDEP 2016a). The site had two leaking fuel tanks removed on October 13, 1993 — one 1,000-gallon leaded-gasoline tank and one 4,000-gallon unleaded gasoline tank. The New Jersey Brownfields database indicates that the property was assigned to the Brownfields Program on August 31, 1994, as a known source and release of groundwater contamination (New Jersey State 2015). Because this property is relatively close to the Project facilities, is a known contaminated site, and has an unclear remedial history, it is possible that contamination associated with this property could be present in the soil in the vicinity of the Project facilities. If contamination is unearthed, Transco will employ best management practices and working with the New Jersey Department of Environmental Protection (NJDEP) Division of Solid and Hazardous Waste to mitigate adverse effects such as re-suspension of impacted sediments during construction. In addition, Transco will follow their Waste Management Procedures, which include an Unanticipated Discovery of Contamination Plan.

Global Sanitary Landfill Superfund Site and Associated CEA: The EPA National Priorities List (NPL) database indicated that the Global Sanitary Landfill, located along Ernston Road in Old Bridge Township, New Jersey, is less than 0.1 mile south of MP10.13 to MP10.38 of the Madison Loop (EPA 2016a). This site has a historical record of groundwater, soil, sediment, and surface water contamination. The Global Sanitary Landfill is a 57.5-acre area used for solid waste disposal from 1968 to 1984 by the Global Landfill Reclaiming Corporation (EPA 2016b). Operations ceased in 1984 after a landfill side-slope failure impacted several acres of adjacent wetlands. In 1989, the site was placed on the EPA National Priorities List (NPL) due to the presence of contaminated leachate and the discovery of buried drums containing hazardous waste in a portion of the landfill. The EPA issued a Record of Decision, which included remedial action objectives for addressing contaminant migration (volatile and semi-volatile organic compounds, pesticides, and metals) from the landfill into groundwater, surface water, sediment, and soil.

The Project is not located within the footprint of the CEA associated with the Global Landfill or its Well Restriction Area (WRA). Therefore, it is unlikely that contamination associated with this site would be present in the soil or groundwater in the vicinity of the project. Trenching associated with the project is planned to be approximately 8 feet bgs in the vicinity of the Global Landfill. If apparent contamination is encountered, Transco will adhere to its Unanticipated Discovery of Contamination Plan.

E.I. DuPont Nemours and Company Site and Associated CEA: The E. I. DuPont Nemours and Company property (DuPont site) is located approximately 1.2 miles northwest of the project, which is outside the EDR search radius. However, this site contains an active NJDEP CEA and WRA that overlaps the Madison Loop from approximately MP9.20 to MP10.31 (NJDEP 2016b). The CEA was established to ensure that uses of the impacted aquifer zone are restricted until constituent standards are achieved. When contaminant concentrations in a CEA exceed maximum contaminant levels (and the designated aquifer use includes potable use), the NJDEP will identify the CEA as a WRA. The CEA for the DuPont site is divided into two portions: (a) groundwater use in the eastern portion is restricted at a depth from the ground surface to 150 feet bgs, and (b) groundwater use in the western portion is restricted at a depth from the ground surface to 190 feet bgs (NJDEP 2016b). The impacted groundwater at the DuPont site includes volatile organic compounds (VOCs) and metals.

A field survey completed by Doyle Land Services, Inc. noted that four groundwater monitoring wells associated with the CEA and WRA are located within 150 feet of the Project facilities. Three groundwater monitoring wells (OS-7S, OS-7I and OS-7D) are located near MP10.16 and MP10.17, and one groundwater monitoring well (OS-6D) is located near MP9.85.

Since the project is located in an active NJDEP CEA and WRA from approximately MP9.20 to MP10.31, contamination associated with the DuPont site could be present. The project in this area will be installed using conventional trenching and HDD to depths up to 75 feet bgs. The actual groundwater contamination plume in this area has been reported at depths more than 150 feet bgs (personal communication, Lasky, 2017). Therefore, it is probable that the Project construction will not impact (or will not be impacted by) contaminated groundwater associated with the DuPont site. Transco's *Unanticipated Discovery of Contamination Plan* outlines the control methods that will be employed in the event of an unanticipated discovery of apparent contamination in soil, groundwater, or sediment when excavating during construction and/or maintenance activities.

2.0 Geological and Hydrogeological Setting

The Project subject to this technical report is located in Old Bridge Township between MP 8.57 and MP 10.36 (corresponding to Stations 99+23 through 193+30, as summarized in **Table 1**).

The Project is located within the Coastal Plain physiographic province. The northern boundary of the Coastal Plain Province is known as the Fall Line boundary line, and deposits associated with the Coastal Plains province extend east and southeast toward and beneath the current shoreline of the Atlantic Ocean. Near the Fall Line, the Coastal Plain deposits appear at the surface where Cretaceous unconsolidated sediments rest unconformably on top of older Triassic and Jurassic bedrock divisions, with successively younger Cretaceous and Tertiary deposits (alternating sandy and clayey formations) appearing toward the southeast. The deposits of the Coastal Plain province, therefore, from a wedge of progressively thickening and progressively more recent strata that dip, in a general sense, toward the east and southeast.

The relevant source materials for the geological and hydrogeological description include the NJ Geological Survey Open File Map 65 (OFM 65) *Bedrock Geology of the South Amboy Quadrangle, Middlesex and Monmouth Counties, New Jersey* (P.J. Sugarman et al., 2005) and the NJ Geological Survey OFM 18 *Surficial Geology of the South Amboy Quadrangle, Middlesex and Monmouth Counties, New Jersey* (S.D. Stanford, 1995). Excerpts of both maps are provided in **Figure 2** of this Technical Report, with the Project extent superimposed on both maps.

2.1 Regional Geology and Soil Classification

2.1.1 Subsurface Geology

The Project site is situated within the subcrop area of various divisions of the Cretaceous Magothy Formation and overlying Tertiary and Quaternary sequences (see **Figure 2**), which include from oldest to youngest:

Cretaceous:	Old Bridge Sand (Kmo) South Amboy Stoneware Clay (Kma) Morgan Beds (Kmm) Cliffwood Beds (Kmc)
Tertiary (Pliocene)	Pennsauken (or Bridgeton) Formation (Tb)
Quaternary	Various terrace or colluvial deposits (Qtl, Qcl) Alluvium (Qal) Estuarine Deposits (Qm)

Detailed description of the general lithologies encountered in these units are provided in the mapping notes to OFM 65 (bedrock geology) and OFM 18 (surficial geology).

Figure 4 represents a topographic and hydrogeologic profile of the linear extent of the Project, which shows the construction elements of the Project, the interpreted intersection of these elements with the geological units summarized above, the vertical position of the interpreted regional water table within the project profile, the location of geotechnical borings and adjacent monitoring wells, the observed or inferred vertical position of the water table (from discrete boring or well data), and the presence of stream crossings and wetlands along the Project profile.

2.1.2 Surface Geology

The majority of the project profile is underlain by the mixed sandy and silty deposits of either Pliocene-aged (Pennsauken Fm.) or Cretaceous-aged (Magothy divisions) Coastal Plain formations, including occasional occurrences of alluvial deposits and colluvial or terrace deposits along streams, as shown in **Figure 2**.

The boring logs of a series of geotechnical borings (as described in **Section 1.4.1**, and shown in **Figure 2** [plan view] and **Figure 4** [profile view]) are provided in **Appendix A**, together with the grain size analyses of representative soil samples that were collected from these borings. **Table 4** summarizes the geotechnical samples by sample ID, corresponding sampling depth, the position of the boring locations along the Project profile, the likely assignment of the geotechnical samples to the stated geological units, the general USCS classification of each sample, and numerical grain size thresholds.

Formal hydrometer testing or permeability testing was not performed for any of the geotechnical samples. However, based on the soil classifications alone (see **Table 4**), the range of permeability would be expected to span a relatively wide rang (estimated in the range of 1 x 10^{-5} to 1 x 10^{-1} cm/sec). Applicable for coarser-grained soils only, Hazen (1892 - *Some physical properties of sands and gravels: Mass. State Board of Health, Ann. Rept. pp. 539-556*) also developed an empirical formula for approximating hydraulic conductivity K that is based on sieve analysis only and is sometimes to used estimate permeability:

$$K = C(D_{10})^2$$

where C = Hazen's empirical coefficient, with C = 100, if D_{10} is expressed in cm, and K is expressed in cm/sec; and

D_{10} is the diameter of 10^{th} percentile grain size of the material (see **Table**

Since unit-specific conductivity is an important factor in the estimation of dewatering rates, AECOM used the geotechnical grain size data to derive a non-parametric estimate of the expected (average) conductivity for a specific geological unit. Although soil boring information is available along some sections of the Project (see **Figure 2** and **Figure 4**), other sections have few test borings or no test borings at all. Since the Project aligns roughly along geological strike of the Cretaceous geological units and also varies greatly in topographic elevation, AECOM believes that the average ('compounded') conductivity value (for each unit) adequately describes the average permeability for a specific unit along the Project as a whole. **Table 4** (4^{th} page) shows a summary of the observed soil types for the five geological units encountered (also reproduced below). Specifically, a reasonable conductivity values was assigned to each soil type (SP = 1x10^{-1} cm/sec; SP-SM = 2.5 x 10^{-2} cm/sec, SW-SM = 7.5 x 10^{-3} cm/sec; SM = 2.5 x 10^{-3} cm/sec; ML = 1.0 x 10^{-4} cm/sec; CL = 1 x 10^{-5} cm/sec). Cross-multiplying these conductivity values with the number of soil types observed (separately for each unit), and dividing by the total number of soil samples (for each unit) resulted in a conductivity estimate for each unit. These average conductivity values were then used in the dewatering calculations (**Section 3** and **Appendix B)**.

USCS Symbol	SP	SP-SM	SW-SM	SM	ML	CL	Compounded Estimated K	
K (est), cm/sec	1.0E-01	2.5E-02	7.5E-03	2.5E-03	1.0E-04	1.0E-05		
K (est), ft/d	283	71	21	7	0.3	0.03	cm/sec	ft/d
Alluvium (Qal)	0	1	0	4	0	0	7.0E-03	20
Pennsauken	0	0	0	1	0	1	1.3E-03	3.6
Magothy (K)	0	6	1	24	7	1	5.6E-03	16
Magothy (Kma)	0	0	0	8	0	1	2.2E-03	6.3
Magothy (Kmo)	0	4	0	3	0	0	1.5E-02	44
total number of samples	*0*	*11*	*1*	*40*	*7*	*3*		

2.2 Site Setting and Land Use

The Madison Loop crosses open land, wetlands, transportation land, upland forest and woodland, industrial and commercial land, residential land, and open water.

Open Land: Open land crossed by the Project includes the portions of the ROW that will be co-located with the existing Transco Lower Bay Loop C ROW, which is currently maintained as herbaceous cover. Transco has identified one foreign utility that will be crossed by the Project. Additional local utilities (e.g., water lines, sewer lines, cable/telephone lines) may also be crossed by the pipeline loop.

Wetlands: Overall, the Project facilities will cross nineteen (19) wetlands. Of these wetlands, nine are classified as palustrine emergent (PEM); one is classified as palustrine scrub-shrub (PSS)/PEM, and three are classified as estuarine emergent (E2EM) wetlands due to their estuarine and intertidal locations. Palustrine forested (PFO) wetlands account for two of the wetlands crossed by the Madison Loop. Additionally, two wetlands were classified as PFO/PEM; one was classified as a PFO/PSS/PEM wetland; and one was classified as an E2EM/PEM wetland. **Section 2.3.1** below further details for the twelve (12) wetland areas crossed within Old Bridge Township.

Transportation Land: Within Old Bridge Township, the Project will cross two public roads (Cheesequake Road and U.S. Highway 9) and one private road (Westminster Boulevard). No railroad lines will be crossed during construction and operation of the Madison Loop.

Upland Forest/Woodland: Overall, the construction of the Madison Loop facilities will temporarily impact upland forests. Upland forest surveys for the Madison Loop were completed in August 2016. The survey indicated that the forestland surrounding the Madison Loop consists mainly of hardwood forest. Dominant species within the stands surveyed include northern red oak, white oak, chestnut oak, red maple, white pine, and black gum. Using a linear regression model to predict the age of sampled trees within each stand, the average age of forest stands within and adjacent to the Madison Loop ranges from approximately 39 to 69 years. No woodlands used for commercial silviculture have been identified along the Madison Loop.

Industrial/Commercial Land: No quarries, underground mines, or strip mines will be crossed by the Project. Several larger-scale commercial developments will be crossed by the Madison Loop. In Old Bridge Township, the parking lot of the New Jersey Transit-Old Bridge Park and Ride facility will be crossed by the Madison Loop (via HDD) at approximate MP 9.50.

Residential Land: Residential land crossed by the Project includes areas of single-family homes, multi-family homes, and apartment complexes.

Open Water: **Section 2.3.1** below further details the open water bodies crossed within Old Bridge Township.

2.3 Site Hydrology

2.3.1 Surface Water and Wetlands

AECOM, on behalf of Transco, conducted field surveys of the Project area to delineate wetlands and associated water bodies within or immediately adjacent to the Project site. The resulting jurisdictional wetlands surveys were submitted to the NJDEP to support the application for the required wetlands disturbance and mitigation permits.

Within the Old Bridge Township footprint of the Project, the field survey identified six (6) intermittent streams within the pipeline alignment (see *Table 2B-1* of the FERC submittal):

- Unnamed tributary to Tennent Brook (MP 8.61), referenced as WW-T01-001, with water quality use FW2-NT and a crossing length of 13 ft via dry open cut methods;

- Unnamed tributary to Tennent Brook (MP 8.76), referenced as WW-T01-002, with water quality use FW2-NT and a crossing length of 11 ft dry open cut methods;

- Unnamed tributary to Tennent Brook (MP 9.02), referenced as WW-T15-003, with water quality use FW2-NT and a crossing length of 7 ft via HDD;

- Unnamed tributary to Tennent Brook (MP 9.08), referenced as WW-T15-002, with water quality use FW2-NT and a crossing length of 2 ft via HDD;

- Unnamed tributary to Tennent Brook (MP 9.21), referenced as WW-T15-004A, with water quality use FW2-NT and a crossing length of 33 ft via HDD;

- Unnamed tributary to Cheesequake Creek (MP 10.05), referenced as WW-T01-004 with water quality FW2-NT and a crossing length of 11 ft via dry open cut.

The delineated waterways described above do not represent sensitive surface waters, as defined in the Guidance Manual for Environmental Report Preparation (FERC August 2003).

Within the Old Bridge Township footprint of the Project, the field survey also identified several wetlands resources as summarized below.

- MP 8.61: PEM wetlands, referenced as W-T01-008, temporarily occupied by workspace project elements only;
- MP 8.70: PEM wetlands, referenced as W-T01-006, temporarily occupied by workspace project elements only;
- MP 8.71: PEM wetlands, referenced as W-T01-007, temporarily occupied by workspace project elements only;
- MP 8.73: PEM wetlands, referenced as W-T15-001, temporarily occupied by workspace project elements only;
- MP 8.76: PEM/PFO wetlands, referenced as W-T01-003, within the pipeline alignment and crossing length of 186 ft;
- MP 8.90: PEM wetlands, referenced as W-T01-009, temporarily occupied by workspace project elements only;
- MP 8.96: PFO wetlands, referenced as W-T01-010, to be crossed via HDD with a crossing length of 33 ft;
- MP 9.21: PEM/PFO wetlands, referenced as W-T15-003, within the pipeline alignment and crossing length of 171 ft;
- MP 9.32: PEM wetlands, referenced as W-T15-002, temporarily occupied by workspace project elements only;
- MP 10.05: PFO wetlands, referenced as W-T15-004, within the pipeline alignment and crossing length of 1 ft;
- MP 10.08: PEM/PSS/PFO wetlands, referenced as W-T01-014, within the pipeline alignment and crossing length of 332 ft; and
- MP 10.17: PEM wetlands, referenced as W-T01-015, temporarily occupied by workspace project elements only.

A comprehensive description of the mapped surface and wetlands resources can be provided to the NJDEP Bureau of Water Allocation upon request, as previously submitted with the March 2017 FERC Certificate submittals and subsequent the NJDEP Land Use Regulation Program Freshwater Wetlands application.

2.3.2 Groundwater-Bearing Units at the Project Site

The principal water-bearing units underlying the Project are comprised of the various divisions of the Magothy aquifer, with groundwater elevations in the Old Bridge Township portion of the Project (based on measurements at monitoring wells across the project area) ranging from 16 to 34-ft NAVD 88, and generally sloping from northwest to southeast (see also **Figure 4** and **Figure 5**). Based on the data reviewed, the erosional remnants of the Pennsauken Fm. (Tb) (where present) overlie the Cretaceous-age units and are generally not saturated, except for the local presence of perched, saturated conditions in the vicinity of the mapped wetlands and intermittent streams. The younger alluvial and terrace/ colluvial deposits should be expected to exhibit similar saturated conditions in the vicinity of wetlands or intermittent streams.

The construction elements listed in **Table 1** (see also **Figure 2** and **Figure 4**) include trenching, horizontal directional drilling (HDD, including entry and exit pits) and directional bores (DB, including bore pits) within (or overlying) these water-bearing unit. **Figure 4** shows the relationship of topographic grade, the various construction elements, the location of local intermittent stream and wetlands crossings and the vertical position of the regional water table. In addition, **Figure 5** shows the contours of regional equal head (groundwater elevation contours), as interpreted from recent depth to water measurements reported from monitoring wells associated with the Global Landfill site and the DuPont site.

The proposed construction and dewatering activities could have a minor impact on the groundwater resources described above. However, much of the potential impacts will be avoided or minimized by utilizing both standard and specialized construction techniques. Since there is an expectation that limited amounts of groundwater will be encountered during trenching (see **Section 3**), Transco will adhere to the requirements and conditions of the NJDEP Temporary Dewatering and Water Allocation permit, in addition to the FERC Upland Erosion Control, Revegetation, and Maintenance Plan and the Wetland and Waterbody Construction and Mitigation Procedures guidelines for all dewatering activities:

- The upper water-bearing unit could sustain minor effects from temporary changes in overland water flow or recharge caused by clearing and grading of the proposed Project areas. In addition, near-surface soil compaction that may be caused by heavy construction vehicles has the potential to reduce the ability of soils to absorb water. These minor impacts will be localized, temporary and will not adversely affect groundwater resources in the Project vicinity.

- It is anticipated that construction dewatering will be necessary along a portion of the trenches (as shown in **Figure 4** and further described in **Table 5**), either as a result of controlling perched water table conditions or because the excavation base will be near or below the regional water table. The effects of the proposed temporary water withdrawal to manage water infiltration into the excavations are expected to be minor, as the construction activities will be typically completed over period of no more than a few days and the localized lowering of the water table will be temporary.

- In order to locally recharge the water-bearing units, Transco proposes to discharge the dewatering fluids (after removal of fines by a combination of installed filter fabric in the construction sumps and/or subsequent filtration via portable, skid-mounted cartridge filters) into well-vegetated upland areas, or into hay bale/dissipation structures in those areas where dense vegetation is absent. Any discharges would be in compliance with an issues Discharge certificate (which will applied for and will be issued separately from the temporary dewatering permit).

- Several supply wells that have the potential to be sources of potable water are located within ¼-mile of the Project area and therefore have the potential to be affected by the construction activities. **Table 3** list the identities and locations of these supply wells (including public supply wells, domestic supply wells and industrial supply wells) as obtained from the NJDEP Bureau of

Water Allocation via a current well search request (NJDEP, February 20, 2018). The locations of these wells relative to the Project footprint are shown in **Figure 6**. Transco's standard mitigation measure is to ensure that no construction equipment, vehicles, hazardous materials, chemicals, fuels, lubricating oils, or petroleum products will be parked, stored, or serviced within a 200-foot radius of any private wells, within a 400-foot radius of any municipal or community wells, or within 100-feet of any waterbody or wetlands, which is consistent with FERC guidelines.

- Within the Old Bridge Township portion of the Project, the well search results indicated eight (8) potential supply wells (two industrial wells and six domestic wells) within ¼-mile of the Project (see **Table 3** and **Figure 6**).

- The construction activities and final land use of the Project are not anticipated to generate long-term degradation of the volume and quality of groundwater resources, as they do not involve conversion to a long-term land use that would threaten the quality of groundwater. Any inadvertent release of hazardous or non-permitted materials during the construction activities will be immediately contained and cleaned-up, in accordance with Transco's Construction Spill Plan.

3.0 Project Dewatering

3.1 Construction Overview and Decision Criteria

After the completion of surveying and staking, and installation of temporary sediment controls and best management practices (BMPs), clearing and grading will occur, as necessary. Once the Project area has been cleared and graded, trench excavation will begin for the installation of the gas pipelines and associated facilities. Away from the HDD and DB segment, the pipe will be installed via open-cut trenching methods. The open-cut trenches are expected to be approximately 5 feet wide to accommodate the installation of 26-inch diameter piping. As shown in **Table 1**, the depths for pipe installation will be approximately 7 feet, with occasional deeper excavations at the indicated stream crossings or directional bore pits.

Figure 4 shows a keyed profile of the construction segments that are anticipated to require construction dewatering, either due to their proximity to perched water table conditions, to nearby intermittent streams or wetlands, or because the base of the excavation is anticipated to be near or below the regional water table. The excavation and dewatering details in **Table 5** are based on information received from Transco (e.g., dimensions of the trenches and/or excavations, the depth of the excavations compared to final site grade, or the duration of construction at each identified segment) and an interpretation of the static head and hydrostratigraphy of the Project area, as follows:

- **Figure 4** (topographic profile of the Project) shows the intersection of the Project elements with mapped intermittent streams or wetland areas. Even in portions of the Project where the regional groundwater table was interpreted to be significantly deeper than the streams or wetlands, groundwater infiltration into excavation segments was assumed to be likely in the vicinity of these freshwater and wetlands areas.

- **Figure 5** shows an interpreted map of the contours of regional equal head (groundwater elevation contours) in the Magothy divisions underlying the Project area. The groundwater elevation contour lines are based on reported groundwater elevation measurements at the Global Landfill site and the DuPont site (off-site wells). The regional water table contours were projected into the topographic profile of the Project (**Figure 4**) and those construction segments where the excavation base either approaches the regional water table or is anticipated to be below the regional water table were assumed to require dewatering.

- **Table 5** shows a comprehensive summary of the stratigraphic and hydrological conditions at each of the construction elements, which in turn serve as input values for the dewatering scenarios and calculated dewatering rates presented in **Section 3.2**.

For the purpose of generating a cumulative estimate of dewatering yield of the Project, and to maintain an adequate level of resolution relative to topography, water table and geological constraints, **Table 5** lists the individual trench segments in 100-ft sections (whether or not these correspond to actual construction sections), in addition to the identity and location of the HDD pits and DB pits (which are listed at their actual long dimensions):

- The potential need for dewatering was identified individually for each element listed in **Table 5**, by examining the presence of perched water table conditions (e.g., intermittent streams and wetlands) or the position of the regional water table relative to the base of the excavation at each individual element. If the excavation base for a specific element is in the vicinity of wetlands or streams or is at or below the regional water table, dewatering was considered to be "likely" ("Yes" in **Table 5**). Conversely, dewatering was considered "unlikely" ("No" in **Table 5**) if the excavation base for a specific element was not in the vicinity of wetlands or streams or was several feet or more above the regional water table.

- The estimated rate of dewatering at each element was based on the conductivity values derived in **Section 2.1.2** (and shown in detail as **Table 3**), as a function of the geological unit intersected by the construction element, the estimated construction duration and the anticipated base of the excavation relative to the water table. The dewatering calculations are shown as **Appendix B**.

It should be noted that the generation of dewatering fluids and mixing of the same with drilling mud at the indicated HDD segments and associated HDD entry and exit pits was assumed to be handled in the context of the overall management of drilling spoils. Any dewatering fluids entrained in mud and drilling spoils will be recirculated to storage tanks for staging and disposal, and were therefore not considered further in this dewatering analysis. However, since it is possible that HDD entry and exit pits may be installed some time prior to commencing the HDD activities, it was assumed that 7-days of dewatering would be necessary for those pits that are at or below the interpreted regional water table.

The Project profile shown as **Figure 4** is a cross-sectional representation of the discrete information shown in **Table 5**.

For the portion of the Project located in Old Bridge Township, this conceptual approach to estimating dewatering rates and yield resulted in the identification of likely dewatering needs between Station 99+23 and 111+00 (i.e., an approximate 1,180-ft stretch in the vicinity of intermittent streams and wetland) and between Stations 175+00 and 192+00 (i.e., an approximate 1,700-ft stretch in the topographically low-lying portion of the Project where the excavation base is expected to be near or below the regional water table).

3.2 Construction Dewatering

3.2.1 Overview

Temporary construction dewatering was anticipated to be necessary in order to manage water infiltration at open trench excavations and at HDD pit or DB pit excavations, in cases when the excavation base was at or below the perched or regionally observed water table. Two different types of excavation scenarios were considered:

- Open cut trenches where the length of the trench greatly exceeds its width. As the excavation proceeds below the static groundwater table, gravity flow (and hence dewatering) was estimated using the base equation for a “partially penetrating line slot with two line sources and gravity flow” (from *Figure 4-3c*, NAVFAC, 1983). Gravity flow to simple line trenches (i.e., construction elements labeled “Trench” in **Table 1** and **Table 5**) was estimated as 2-times (i.e., 2-sided) the one-dimensional line flow to the trench elements, on a unit basis per 100-ft trench length.

- Square or slightly elongated pit excavations, where the length of the excavation is equal to or moderately greater than its width. When excavation is anticipated to proceed below the static groundwater table, gravity flow was estimated using the *Dupuit-Forchheimer approximation* of radial flow to a well that is centered in the excavation and having an effective radius that is proportional to the area of the excavation itself. The estimated dewatering rate has the effect of lowering the water table to the desired excavation base elevation at the perimeter of the excavation (and lower than the excavation base elevation in the center of the excavation).

The dewatering rates estimates summarized in **Table 5** are based on input values of total aquifer thickness H, dewatered saturated thickness h_w, permeability (or conductivity) k, the estimated radius of influence $R_{(o)}$, and the effective excavation radius r_e (in the case of pit excavations).

3.2.2 Estimating the Radius of Influence

According to *Navy Facilities Engineering Command (NAVFAC) Technical Manual P-418, page 4-2*, the radius of influence $R(_{o})$ is defined as the radius of a circle beyond which pumping of a dewatering system has no significant effect on the original groundwater level or piezometric surface. Absent site-specific pumping tests, the value of $R_{(o)}$ is commonly estimated from the *Siechart equation* below (see also NAVFAC P-418, Page 4-24) (originally proposed by Kyrieleis and Siechart, 1930):

$$R_{(o)} = C\,(H - h_w)\,\sqrt{k}$$

where *R(o): in feet*
C = 3, for gravity flow to a well
$(H - h_w) = \Delta h$, drawdown in feet
k = coefficient of permeability in micrometer / sec (µm/sec)

For all construction elements, the drawdown value (∆h) was computed as the anticipated depth of the excavation minus 1-ft (i.e., the perched or regional water table was assumed to be 1-ft below grade). This is a simplified approach which results in conservative (i.e., 'high') estimates of potential dewatering rates. In addition, since excessively large values of $R_{(o)}$ are unlikely to develop, because the dewatering duration at each construction element will be too short to result in equilibrium [steady-state] drawdown cones, the values of $R_{(o)}$ as generated by the equilibrium Siechart equation was multiplied by 0.5. This safety factor essentially shortens the estimated radius of influence, which in turn steepens the residual head differences and therefore leads to larger, more conservative estimates of dewatering rates.

3.2.3 Open Cut Trenches

The estimated dewatering along an open-cut line trench was based on solving for a "partially penetrating line slot with two line sources and gravity flow" (Navy Technical Manual "*Dewatering and Groundwater Control*", NAVFAC P-418, as per *Figure 4-3c*, *Equation 3, Page 4*, 1983). Therefore, the estimated dewatering along an open-cut trench was estimated from the equation below:

$$Q = \left(0.73 + 0.27\,\frac{H - h_w}{H}\right)\frac{k_x}{2\,L}\left(H^2 - h_w^2\right) \times 2$$

where *Q = required dewatering (pumping) per unit length of open-cut trench (ft^3/sec/ft)*
H = saturated thickness at each construction element
h_w = dewatered saturated thickness (aquifer thickness H minus the required drawdown ∆h)
k_x = coefficient of permeability (ft/sec), estimated from the information provided in Table 3
L = radius of influence $R_{(o)}$, as computed by the Siechart equation multiplied by 0.5

The dewatering rate at each of the trench elements was computed by multiplying the estimated unit dewatering rates (via the equation shown) by the length of the trench segment (up to 100-ft) and converting to a convenient unit (gallons per minute, gpm). The converted estimated dewatering rates (in gpm per trench segment) are summarized in **Table 5.** The estimated total yield was calculated by multiplying the dewatering rate with the anticipated dewatering duration, and expressed either as (a) million gallons per month (Mgal/month, a unit consistent with the required input for form BWA-002) or b.) expressed as the linear yield (gal/ft, also a required input for Form BWA-002) by dividing the total yield by the length of the construction segment.

3.2.4 Other Excavations

The estimated dewatering along for pit excavations where the sides are equal to or of similar proportions was estimated by solving the *Dupuit-Forcheimer* approximation of radial flow to a well having an effective radius that is proportional to the area of the excavation itself. The governing equations are as follows (for example, J. Powers, *Construction Dewatering, New Methods and Applications*, 2007), in consistent units:

Estimate of effective radius r_e: $$r_e = \sqrt{\frac{a \cdot b}{\pi}}$$

Estimate of radius of influence $R_{(o)}$ $$R_O = C \cdot (H - h) \cdot \sqrt{k} + r_e$$

Estimate of gravity flow to well with radius r_e: $$Q = n \cdot q = \frac{\pi \cdot k \cdot (H^2 - h^2)}{\ln\left(\frac{R_O}{r_e}\right)}$$

where

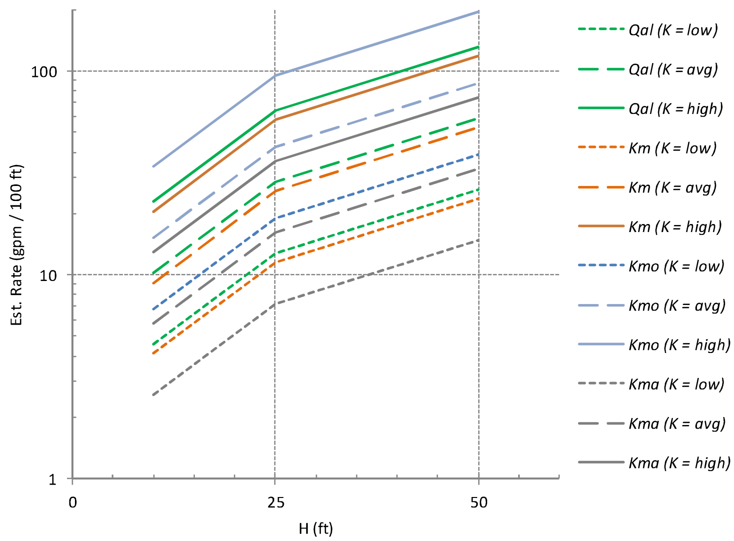
Q = overall flow rate [m^3/s]
n = number of well points (or sumps)
q = flow rate per well point [m^3/s]
k = hydraulic conductivity [m/s]
H = total head of the water table aquifer [m]
h = total head of dewatered aquifer [m]
R_O = radius of influence [m]
r_e = effective radius of dewatering [m]
a = width of excavation [m]
b = length of excavation [m]

Only four (4) such construction elements (the two bore pits for the Godenk Drive crossing directional bore, the exit pit for the Garden State Parkway directional bore at Sta. 240.90, and the entry pit for the HDD at Sta. 253.02) were anticipated to require dewatering, based on the decision criteria stated in **Section 3.1**. The input and output data for these four project elements are shown in **Appendix B** and are summarized in **Table 5**.

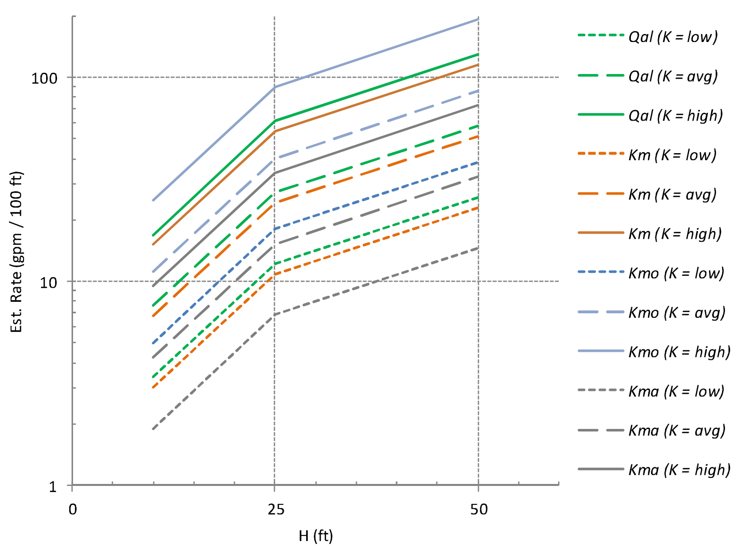
3.2.5 Uncertainties

Since the geotechnical borings did not encounter a clearly defined or regionally extensive aquitard, the aquifer thickness contributing to the dewatering flow (H in the set of equations in **Sections 3.2.2** through **3.2.4**) is generally unknown. Lesser values of H tend to minimize the rate of estimated dewatering, whereas greater values of H tend to maximize the rate of estimated dewatering. Therefore, separate dewatering rates were computed based on three separate assumptions for H (10-ft, 25-ft, and 50-ft), in conjunction with three separate values for K: a high value (=5x the average value), the average value (as stated in **Section 2.1.2**), and a low value (1/5th the average value). This uncertainty analysis was conducted for four of the geological units (Qal, Km [undivided], Kmo, and Kma). The tabular and graphic output of this analysis for variable values for H and K is shown in the plot below (for excavation depths of 7-ft and 12-ft, respectively).

H (ft)	Alluvium, Qal (gpm / 100 ft)			Magothy, K (gpm / 100 ft)			Magothy, Kmo (gpm/ 100 ft)			Magothy, Kma (gpm/100 ft)		
	for K (cm/sec)			for K (cm/sec)			for K (cm/sec)			for K (cm/sec)		
	Low	Avg	High	Low	Avg	High	Low	Avg	High	Low	Avg	High
for excavation d = 7 ft	1.4E-03	7.0E-03	3.5E-02	1.1E-03	5.6E-03	2.8E-02	3.1E-03	1.5E-02	7.7E-02	4.4E-04	2.2E-03	1.1E-02
10	4.6	10.3	22.9	4.1	9.2	20.5	6.8	15.2	34.0	2.6	5.8	12.9
25	12.8	28.7	64.2	11.5	25.7	57.4	19.0	42.5	95.1	7.2	16.2	36.2
50	26.3	58.9	131.6	23.5	52.6	117.7	39.0	87.2	194.9	14.8	33.2	74.2
Avg. Rate (gpm/100 ft)	23.9			49.6			82.1			13.5		



H (ft)	Alluvium, Qal (gpm / 100 ft)			Magothy, K (gpm / 100 ft)			Magothy, Kmo (gpm/ 100 ft)			Magothy, Kma (gpm/100 ft)		
	for K (cm/sec)			for K (cm/sec)			for K (cm/sec)			for K (cm/sec)		
	Low	Avg	High	Low	Avg	High	Low	Avg	High	Low	Avg	High
for excavation d = 12 ft	1.4E-03	7.0E-03	3.5E-02	1.1E-03	5.6E-03	2.8E-02	3.1E-03	1.5E-02	7.7E-02	4.4E-04	2.2E-03	1.1E-02
10	3.4	7.6	17.0	3.0	6.8	15.2	5.0	11.2	25.1	1.9	4.3	9.6
25	12.2	27.2	60.8	10.9	24.3	54.4	18.0	40.3	90.0	6.9	15.3	34.3
50	25.8	57.7	129.0	23.1	51.6	115.4	38.2	85.5	191.1	14.5	32.5	72.7
Avg. Rate (gpm/100 ft)	21.3			47.3			78.4			12.0		



The uncertainty analysis suggests that estimated dewatering rates can vary over approximately one order of magnitude for the stated input ranges for H and K. Therefore, the applied dewatering rates shown in **Table 5** (per 100-ft segment or any pro-rated portion thereof) are average values derived from the permutations shown above (yellow cells only).

- For the Qal and the Kma units (which tend to be thinner and likely contain lithologies with a wider range of permeabilities), the input dewatering rates (21.3-23.9 gpm/100 ft and 12.0-13.5 gpm/100 ft, respectively) were derived by averaging the output values for H=10 ft, H=25 ft, and for low K, average K, and high K values.

- For the Km and Kmo units (which tend to be thicker and consist of lithologies that tend to contain more permeable units), the input dewatering rates (47.3-49.6 gpm/100 ft and 78.4-82.1 gpm/100 ft, respectively) were derived by averaging the output values for H and K as shown above, with a bias toward the greater values of H and K.

Finally, the gravity flow (=dewatering rate) at each construction element was estimated under the assumption that the entire excavation will be open (and therefore acting as a gravity drain) at any given time. It should be noted, however, that standard construction methods typically seek to minimize the area of open excavation at any time.

3.2.6 Limitations

The dewatering analysis presented above is based on stratigraphic and groundwater-related data collected (and interpreted) from geotechnical test borings installed by AECOM. Since the anticipated soil characteristics along the project profile are heterogeneous, the estimates of the average expected permeability coefficient were made from the individual soil classifications of geotechnical samples (separate for each of the geological units) and, if applicable, also using Hazen's convention. Consequently, the individual dewatering estimates presented in **Table 5** could be under- or over-estimated depending on the actual subsurface conditions at each excavation.

The actual dewatering volumes generated during linear construction efforts are often less than those estimated for permitting purposes, since in practice the construction methods employed by the contractor typically seek to minimize infiltration into the excavation (for example, by minimizing the area and time period over which an excavation is open below the water table). Therefore, the dewatering rates (gpm per stated segment length) and yields (yield per month [Mgal/month] and linear yield [gal/ft] should be viewed as conservative estimates.

3.2.7 Estimated Dewatering Discharge Rates

The anticipated dewatering rates for the specified construction elements are shown in **Table 5**:

- 2.96 Mgal/month or 315 gal/ft for the entire length of the Project located in Old Bridge Township; when considering only the elements that were anticipated to be dewatered, the effective linear yield was estimated to be 963 gal/ft.

These dewatering estimates were derived using conservative assumptions throughout and provide a cumulative estimate for the entire Project as located in Old Bridge Township. For those elements that were predicted to result in excavations that extend to or below the static groundwater table, temporary construction dewatering will be necessary to facilitate open-cut trench excavation and to maintain dry conditions within the trench during installation of the piping sections. Based on Transco's current schedule, it is anticipated that the construction dewatering will be implemented over a period of approximately 134 days for the portion of the Project portion located in Old Bridge Township, with dewatering, when and if necessary, occurring 24-hours per day. The estimated duration of dewatering at each trench segment (as provided by Transco) is shown in **Table 5**.

The construction dewatering was analyzed for the trench segments and the pit excavations features, by first estimating the radius of influence and then calculating an equilibrium dewatering (pumping) rate to maintain the water level at or below the base of the excavation. The construction dewatering analysis results are based on the anticipated depth to groundwater, the projected depth of the excavation beneath the water table, and the permeability coefficients derived from a review of the soil classification and gradation curves for soil samples collected from the geotechnical borings**.**

Table 5 expresses these dewatering estimates using the following units:

- Dewatering rate in gallons per minute (gpm), which should be considered a long-term average dewatering rate, meaning that initial dewatering may occur at a faster rate and later dewatering may occur at a slower rate, as would be expected when the head difference between the outside and the inside approach one another during prolonged dewatering.

- Yield rate per linear foot, in gallons per foot (gal/ft), which represents a measure of the total estimated yield of each excavation segment (in gallons = rate [gpm] x duration [days] x 1440 min/day) divided by the length of each construction segment: gal/ft = Yield (gal) / Length (ft)

Based on the data shown in **Tables 4** and **5**, the estimated dewatering yield in Old Bridge Township portion of the Project varies over one order of magnitude, with the higher linear yield rates apparent at Stations 108+00 through 111+00 and at Stations 175+00 through 186+00. On average, and including the Project segments that are not anticipated to require dewatering, the linear yield was estimated to be 315 gal/ft.

Note that the dewatering rates and yield summarized in **Table 5** should be considered estimates that are based on the assumption that each segment will be fully exposed to infiltrating groundwater along its entire length or its entire footprint. From a practical perspective, this is unlikely to occur as typical construction methods seek to minimize water infiltration by sequential trenching and backfilling operations. In general, the subsurface soils along the Project alignment have moderate to low permeabilities, which will limit the amount of infiltration and continuing recharge. However, in segments where coarser alluvial or estuarine soils may be encountered, or in the vicinity of streams or wetlands, the actually encountered yields may temporarily approach or even exceed the estimated conditions shown in **Table 5**.

3.2.8 Anticipated Methods of Dewatering

During the dewatering of the Project segments, infiltrating groundwater (and any stormwater run-on) will be removed from the excavation by using properly-sized sump pumps, well point systems, and/or constructed dewatering sumps by grading the excavation base to a collection point. The actual means and methods of construction dewatering will be determined by Transco's construction contractor, or as specified in the construction documents. The dewatering construction plans will also specify one or more settling tanks to allow for the removal of sediments and solids, appropriately-sized cartridge filters prior to recharge, and properly constructed recharge features (such as hay bale structures) to facilitate the permitted on-site recharge.

It should be noted also that all drilling mud that will be generated at the HDD launch and exit pits (including any infiltrating groundwater into these pits) will be staged in properly sized and secured containers and transported off-site for proper disposal at permitted facilities. No drill mud (or infiltration water containing drill mud) will be discharged alongside the Project extent.

4.0 Environmental Impact

4.1 Potential Impacts to Groundwater Supply and Nearby Groundwater Users

The construction dewatering analysis (**Section 3** and **Appendix B**) suggests that the pumping radius of influence may extend between approximately 50 to 200-ft from specific excavation segments. In general, however, due to the short-term nature of dewatering, the actual radius of influence will be less. Based on Transco's current construction schedule, groundwater dewatering will be performed for not more than 2 days at any given 100-ft construction segment, with longer dewatering likely at some of the indicated stream and road crossings. Dewatering of the excavation segments will be completed to a depth of generally not more than 6-ft below the anticipated groundwater surface. The groundwater that will be affected by the proposed dewatering will be either localized, perched water-bearing zones in the vicinity of streams or wetlands, or water stored in low-lying estuarine or laterally extensive alluvial units, or the regionally saturated aquifer soils of the various Cretaceous unconsolidated units when the land surface is near the regional groundwater table (see **Figure 4**).

Away from alluvial units or estuarine deposits, the actual dewatering rates are anticipated to be relatively modest and together with the potential intermittent nature of the withdrawal, the data suggest that the proposed withdrawal will not adversely impact the local groundwater resources. Furthermore, the well search completed for the due diligence phase of the Project did not identify private or public water supply wells that are located within 50- to 200-ft estimated radius of influence for the Project (see also **Figure 6**). The regional groundwater table in the Project vicinity is represented by the saturated Magothy aquifer soils which typically occur at elevations of 30-ft NAVD 88 or less (**Figure 4** and **Figure 5**) in the Old Bridge Township portion of the Project.

4.2 Potential for Spreading Groundwater Contamination

AECOM, on behalf of Transco, has completed a review of various environmental databases, as described in **Section 1.4.2** and summarized in **Table 2** of this technical report. The purpose of the review was to identify sites of potential environmental concern within or adjacent to the Project site. The search area extended outward and perpendicular to the circumference of the Project Site to a total distance of 0.25 miles in each direction. In addition to known contaminated NJ Sites, the search also included data for state and federal, public and private water supply. Within the Old Bridge Township portion of the Project, two sites that were identified within 0.25 miles (Global Landfill CEA and DuPont CEA) are known to have associated groundwater concerns. Water quality sampling along these segments of the Project is being completed by Transco to discern potential groundwater impacts in the Project vicinity. It should be noted, however, that the estimated radius of influence that will result from managing infiltration into the excavation is likely less than 200-ft, which limits the potential for migration of impacted groundwater, if any. In addition, the depth of reported groundwater impacts within the DuPont CEA is greater than 150-ft, while any required dewatering along the Project would be occurring at depths not greater than 7-15 ft bgs.

4.3 Potential Impacts to Wetlands and Waterbodies

It is possible that the pumping of groundwater from certain excavation elements will temporarily reverse the hydraulic gradient that may ordinarily allow for shallow groundwater to discharge into nearby wetlands and surface water bodies (when present). Therefore, the potential exists that the water table across some of the nearby wetland areas may be temporarily lowered and that the mapped surface water bodies may experience a short-term decrease in flow as a result of dewatering. None of these effects are considered to be severe or long-term in nature, as the dewatering is anticipated to be short in duration and relatively minor in volume. In addition, in the Old Bridge Township portion of the Project the mapped surface water bodies have intermittent flow, suggesting that the ambient discharge to these streams is not continuous and dependent on precipitation events or temporarily perched water table conditions.

4.4 Potential for Salt Water Intrusion

In the Old Bridge Township portion of the Project, there is no potential for salt water intrusion into previously non-impacted groundwater resources. The closest principal unit that shows signs of saltwater intrusion is the Raritan Farrington sand (Krf), which occurs underneath the Old Bridge sand (Kmo) and is separated from the Kmo by the thick confining unit of the Woodbridge Clay (Krw).

5.0 References

Environmental Data Resources, Inc. (EDR). 2016c. DataMap Corridor Study, Madison Loop, South Amboy, NJ, 08879, Inquiry Number: 4726085.2s. September 19, 2016.

U.S. Environmental Protection Agency (EPA). 2016a. Superfund National Priorities List Sites-by State. https://www.epa.gov/superfund/national-priorities-list-npl-sites-state. Accessed January 3, 2017.

EPA. 2016b. EPA Superfund Program: Global Sanitary Landfill, Ild Bridge Township, New Jersey. https://cumulis.epa.gov/supercpad/cursites/csitinfo.cfm?id=0200398&msspp=med

Hazen, W., 1892, Some physical properties of sands and gravels: Mass. State Board of Health, Ann. Rept. pp. 539-556.

Kyrieleis, W. and Siechart, W., 1930, Grundwasserabsenkung bei Fundierungsarbeiten, Berlin.

Lasky, Loren. 2017. Case Manager of the E.I. DuPont Nemours & Company Site. New Jersey Department of Environmental Protection. NESE Project Contact Report, phone call on February 14 and 15, 2017 from Bob Meyers, Ecology and Environment, Inc., Lancaster, New York.

NAVFAC, 1983, Dewatering and Groundwater Control, Navy Manual P-418,

New Jersey Department of Environmental Protection (NJDEP). 2016a. Open Public Records Act, Data Miner. http://datamine2.state.nj.us/dep/DEP_OPRA/. Accessed January 3, 2017.

NJDEP. 2016b. NJ-Geo Web. http://www.nj.gov/dep/gis/geowebsplash.htm. Accessed January 3, 2017.

New Jersey State. 2015. Brownfields SiteMart. http://www.njbrownfieldsproperties.com/SiteInformation.aspx?Site_Number=8072. Accessed January 3, 2017.

NJDEP Office of Water Allocation and Well Permits, February 20, 2018, 0.25-mile Well Search Results Transmittal.

Powers, J., Corwin, A.B., Small, P.C. and Kaeck, W.E., 2007, Construction Dewatering and Groundwater Control, New Methods and Applications, 3rd Edition, 656 pp.

Sharma, H. and Reddy, K., 2004, Geoenvironmental Engineering: Site Remediation, Waste Containment, and Emerging Waste Management Technologies, Wiley, 992 pp.

Stanford, S.A., 1995, Surficial Geology of the South Amboy Quadrangle, Middlesex and Monmouth Counties, New Jersey (OFM 18).

Sugarman, P.J. at al,, 2005, Bedrock Geology of the South Amboy Quadrangle, Middlesex and Monmouth Counties, New Jersey (OFM 18).

Woodward, J., 2005, An Introduction to Geotechnical Processes, CRC Press, 136 pp.

Figures

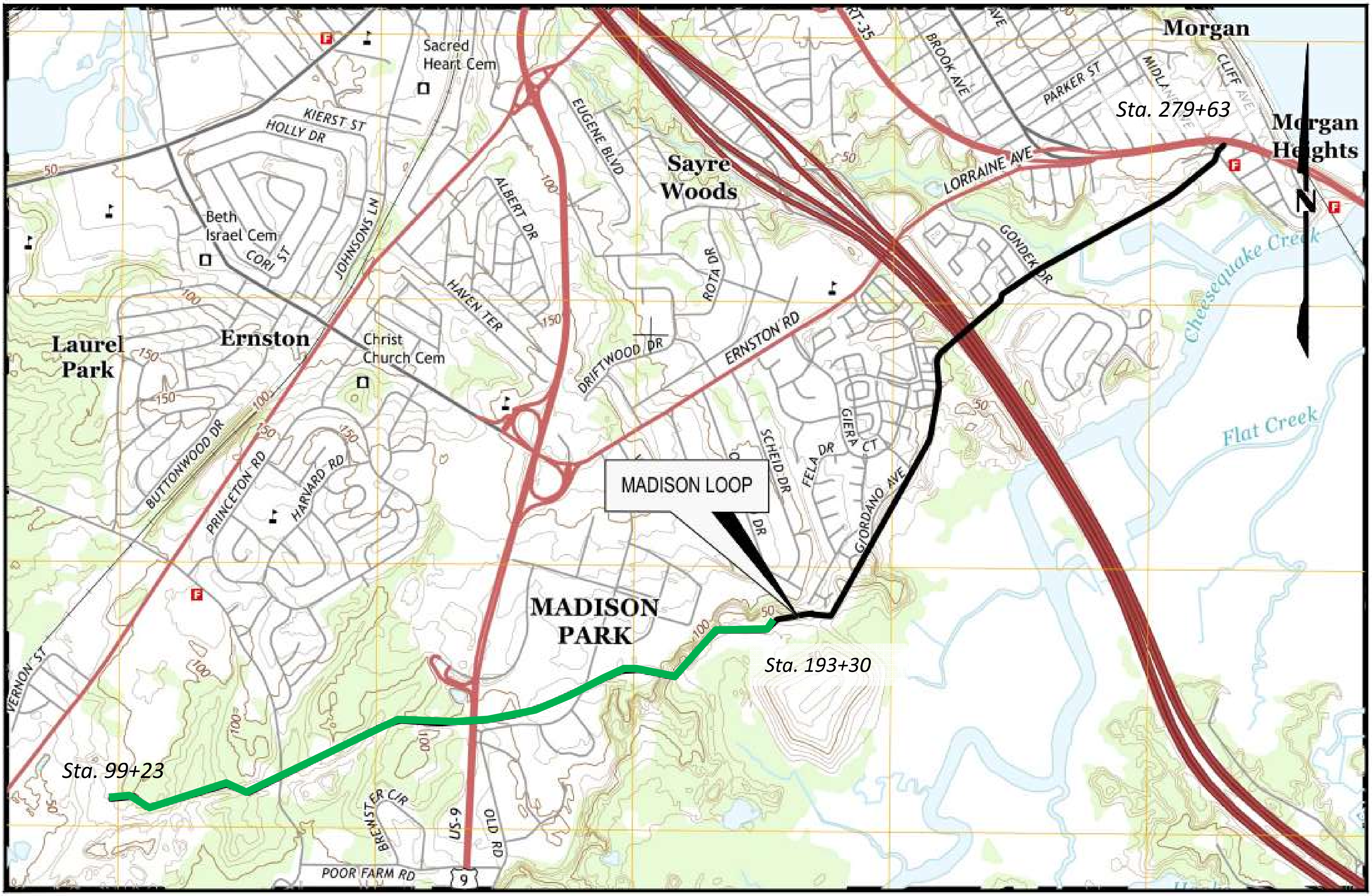
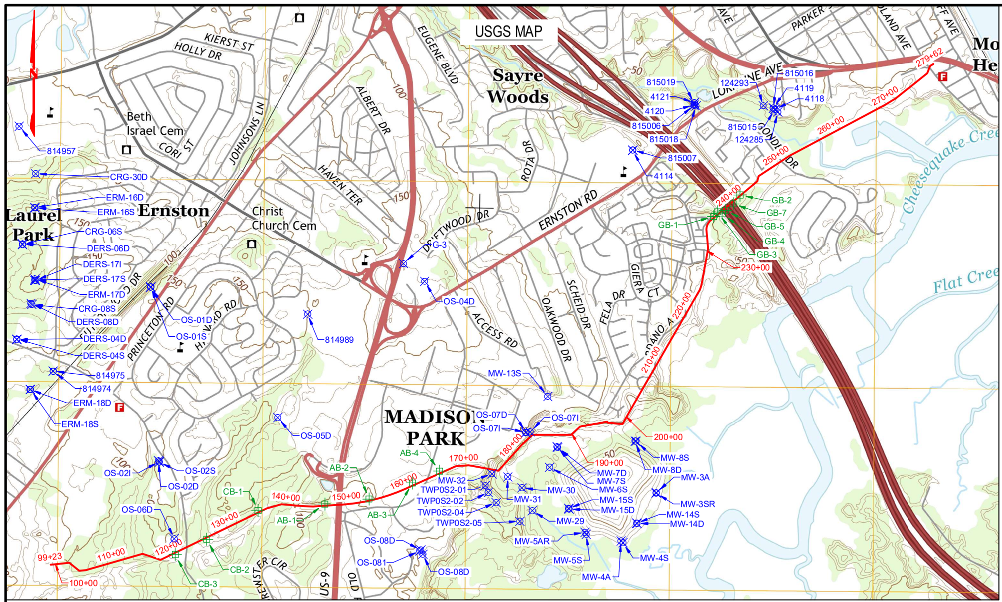
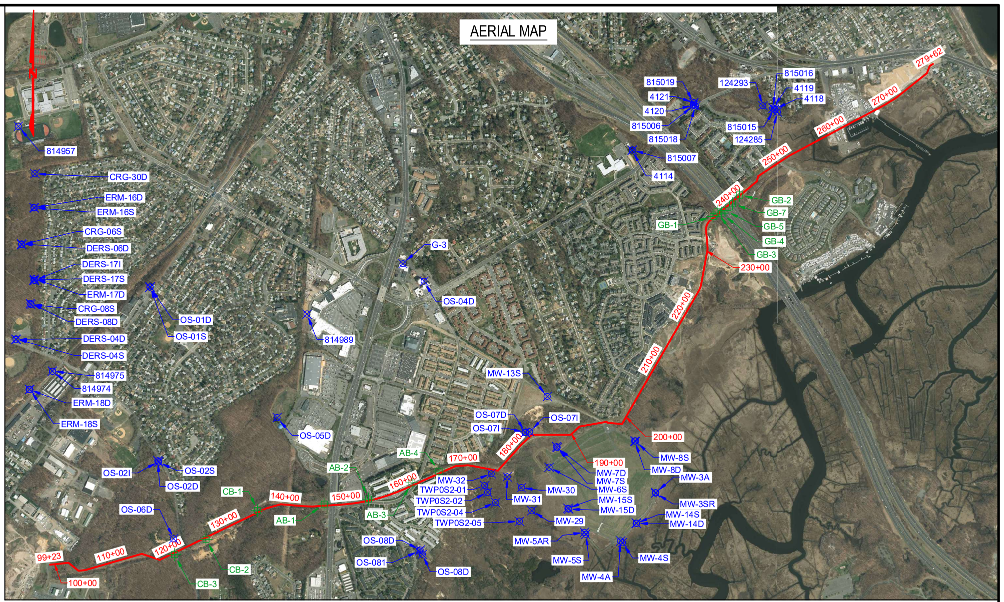
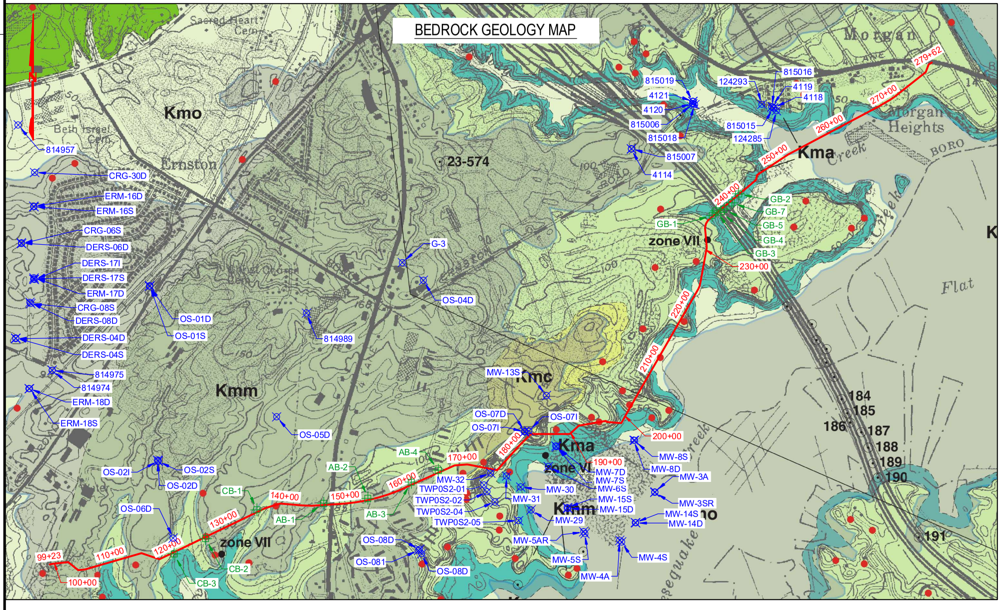


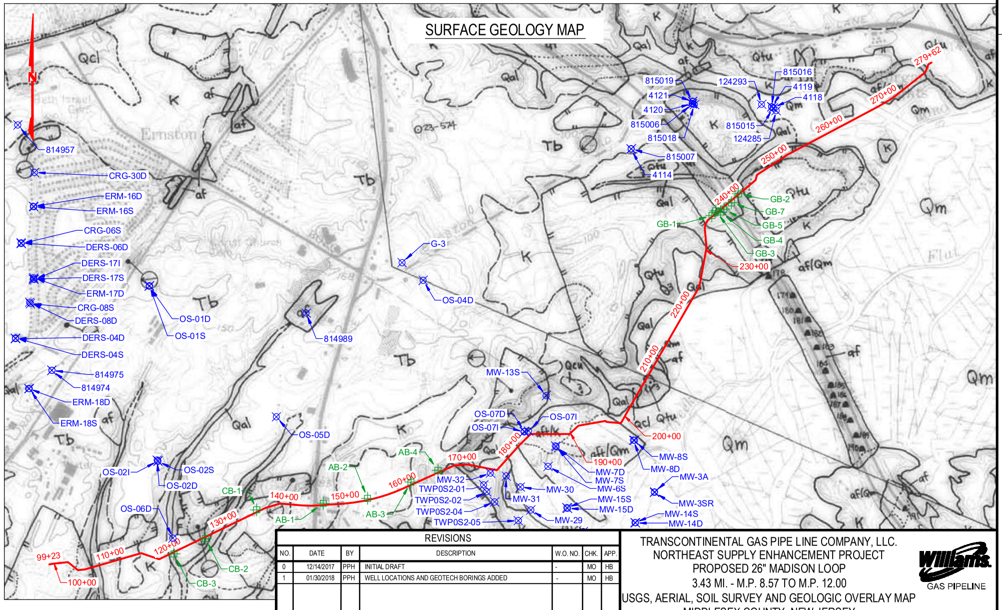
Figure 1 – USGS Map showing Proposed Dewatering Sources in Support of BWA-002 (Old Bridge Township) – Sta. 99+23 to Sta. 193+30 Northeast Supply Enhancement Project (NESE) – Madison Loop

Old Bridge Township portion of Madison Loop (Sta. 99+23 to Sta. 193+30)









NOTES:

1. USGS MAP FROM 7.5' QUADRANGLE, SOUTH AMBOY, NJ-NY 2014.
2. AERIAL IMAGERY OBTAINED FROM NJ OFFICE OF INFORMATION TECHNOLOGY (NJOIT), OFFICE OF GEOGRAPHIC INFORMATION SYSTEMS (OGIS).
3. BEDROCK GEOLOGY FROM OPEN FILE MAP OFM 65 ENTITLED "BEDROCK GEOLOGY OF THE SOUTH AMBOY QUADRANGLE, MIDDLESEX AND MONMOUTH COUNTIES, NEW JERSEY", DATED 2005.
4. SURFACE GEOLOGY FROM OPEN FILE MAP OFM 18 ENTITLED "SURFICIAL GEOLOGY OF THE SOUTH AMBOY QUADRANGLE, MIDDLESEX AND MONMOUTH COUNTIES, NEW JERSEY", DATED 1995.

WELL LOCATIONS
GEOTECHNICAL BORING

AECOM
625 WEST RIDGE PIKE, SUITE E-100
CONSHOHOCKEN, PA 19428
(610) 832-3500

REVISIONS

NO.	DATE	BY	DESCRIPTION	W.O. NO.	CHK.	APP.
0	12/14/2017	PPH	INITIAL DRAFT	-	MO	HB
1	01/30/2018	PPH	WELL LOCATIONS AND GEOTECH BORINGS ADDED	-	MO	HB

TRANSCONTINENTAL GAS PIPE LINE COMPANY, LLC.
NORTHEAST SUPPLY ENHANCEMENT PROJECT
PROPOSED 26" MADISON LOOP
3.43 MI. - M.P. 8.57 TO M.P. 12.00
USGS, AERIAL, SOIL SURVEY AND GEOLOGIC OVERLAY MAP
MIDDLESEX COUNTY, NEW JERSEY

GAS PIPELINE

DRAWN BY: PPH	DATE: 12/13/2017	ISSUED FOR BID: TBD	SCALE: 1" = 1000'
CHECKED BY: MO	DATE: 12/13/2017	ISSUED FOR CONSTRUCTION: TBD	REVISION: 1
APPROVED BY: HB	DATE: 12/13/2017	DRAWING NUMBER: Figure 2	SHEET 01 OF 8
W/O:			

Drawn By & Date/Time: haasp Jan 30, 2018 - 10:42am
Drawing Location & Name: S:\Projects\ENV\60552906_NESE_Water\400-Technical\431- Dewatering\CAD\00 - Madison Dewatering_Maps.dwg

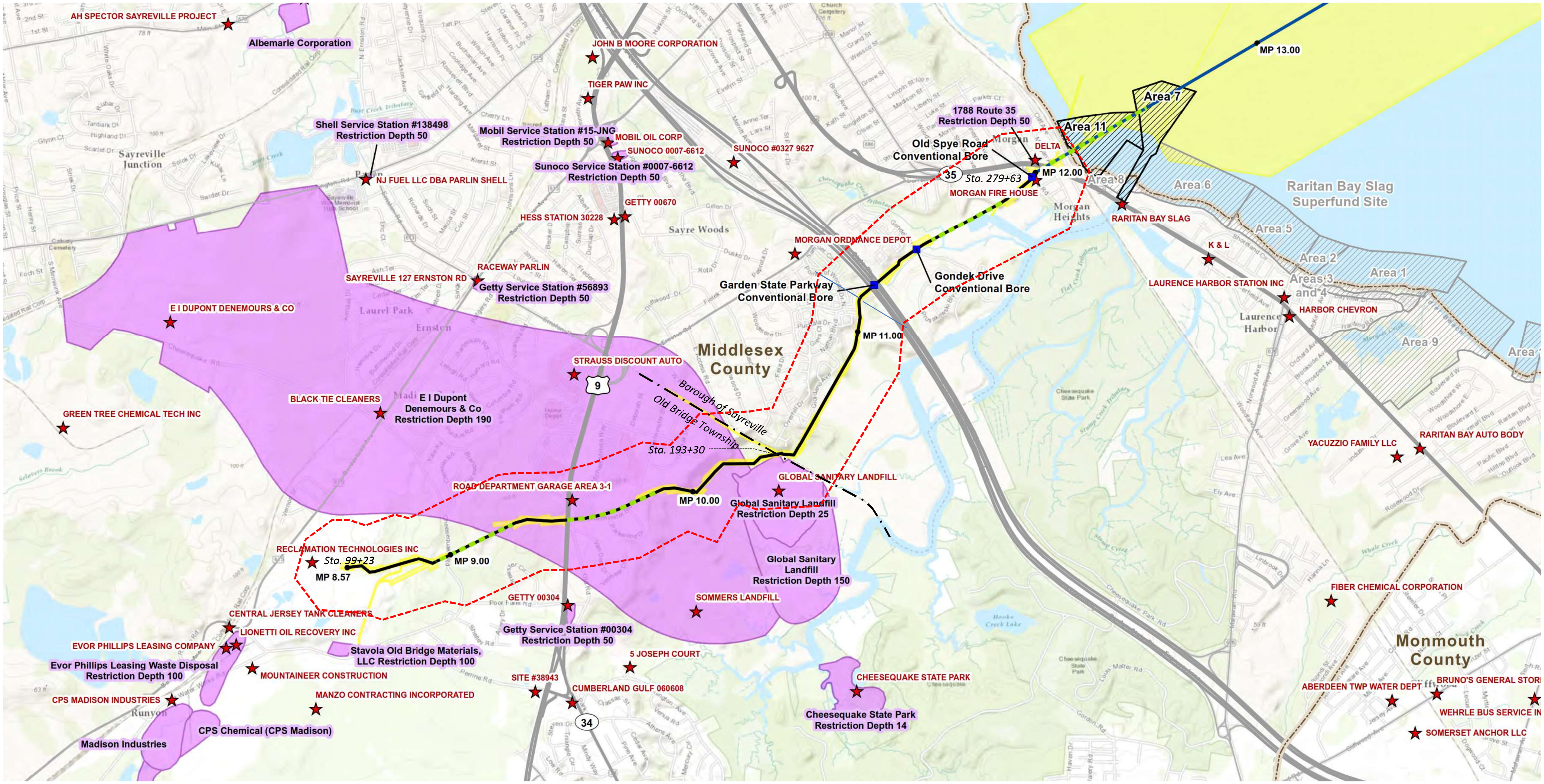


Figure 3 Hazardous Waste and Known Contaminated Sites within ¼-mile Radius in Support of BWA-002 (Old Bridge Township) Northeast Supply Enhancement Project (NESE)

¼-mile radius corridor from Sta. 99+23 to Sta. 279+63

NJDEP Classification Exception Area (CEA)

NJDEP Known Contaminated Site

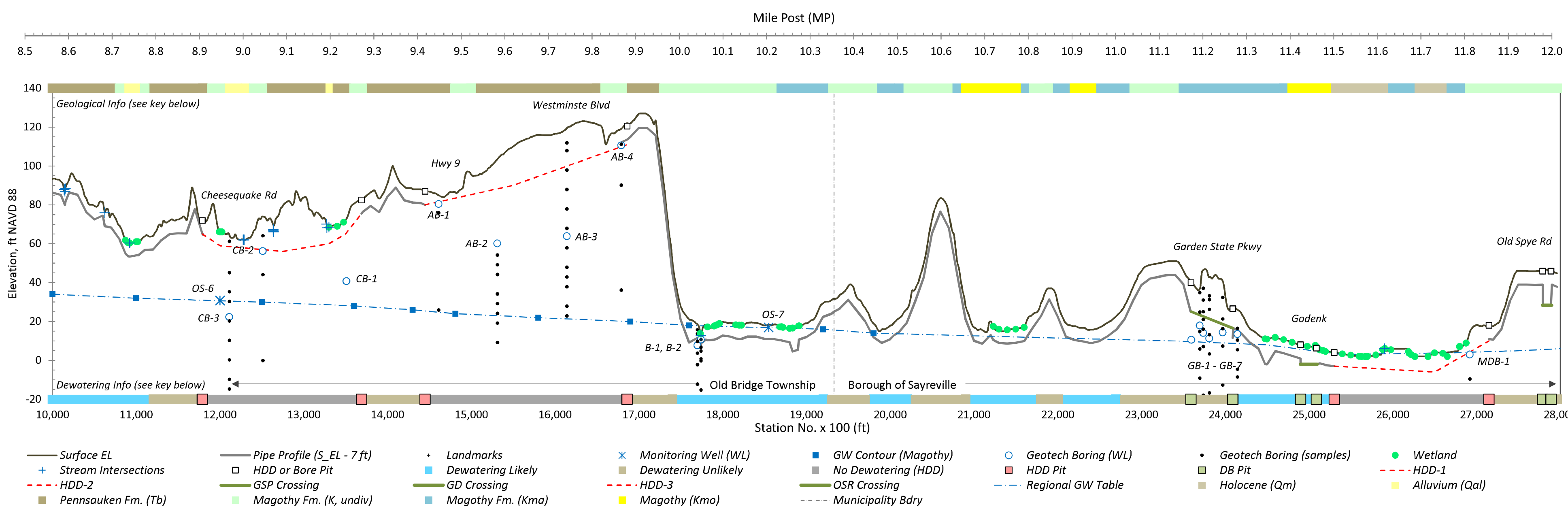
0 0.25 0.5
Miles

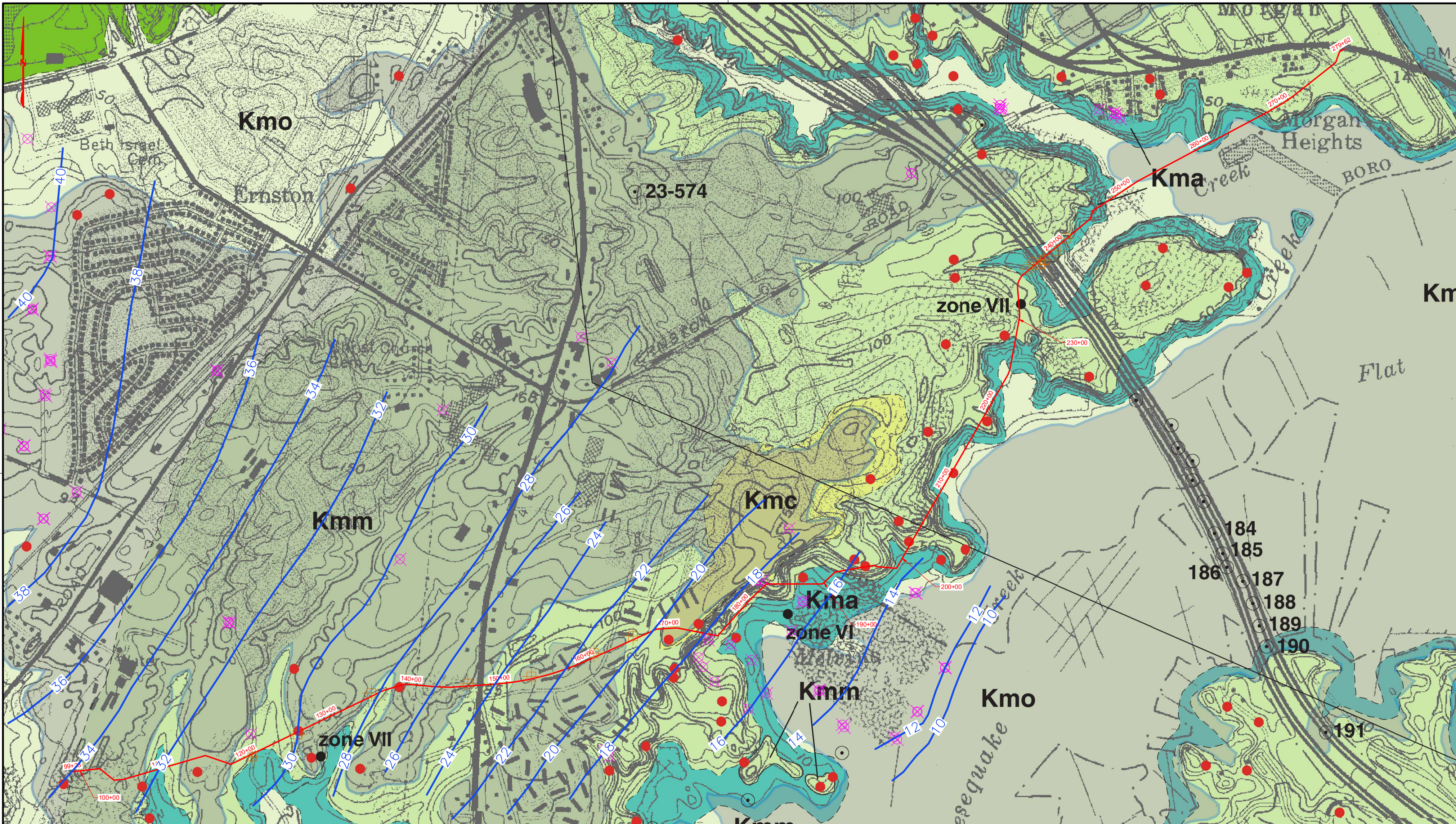
N

Figure adapted from Williams Figure 2A-5 (dated 3/22/2017)

Figure 4 - Topography and Hydrogeological Project Profile

Northeast Supply Enhancement (NESE) Project - Old Bridge Township (BWA-002)





BEDROCK GEOLOGY MAP

NOTES:

1. BEDROCK GEOLOGY FROM OPEN FILE MAP OFM 65 ENTITLED "BEDROCK GEOLOGY OF THE SOUTH AMBOY QUADRANGLE, MIDDLESEX AND MONMOUTH COUNTIES, NEW JERSEY", DATED 2005.

WELL LOCATIONS

GEOTECHNICAL BORING

28 GROUNDWATER ELEVATION CONTOUR

AECOM
625 WEST RIDGE PIKE, SUITE E-100
CONSHOHOCKEN, PA 19428
(610) 832-3500

REVISIONS

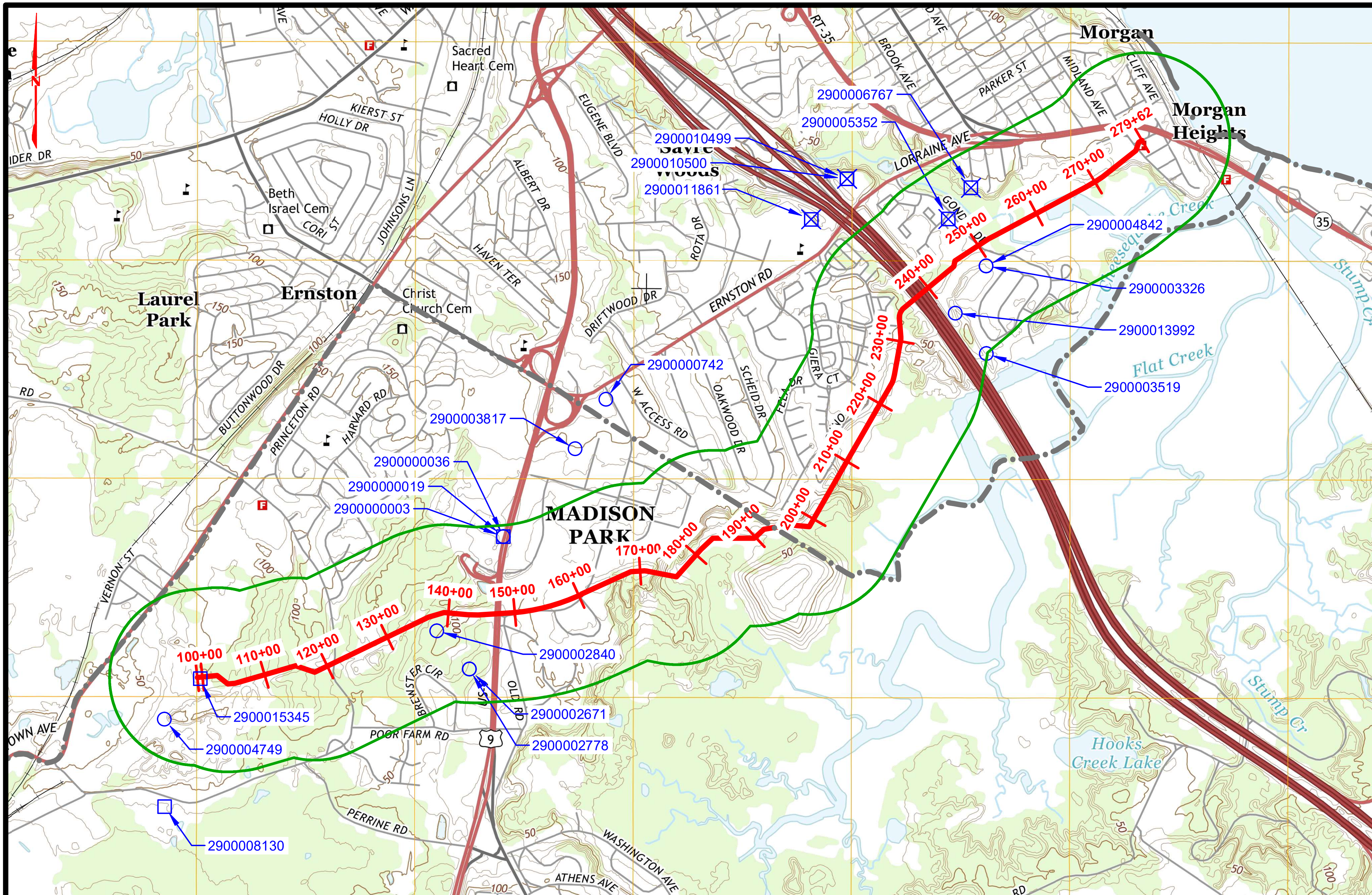
NO.	DATE	BY	DESCRIPTION	W.O. NO.	CHK.	APP.
0	01/31/2018	PPH	INITIAL DRAFT	-	MO	HB

TRANSCONTINENTAL GAS PIPE LINE COMPANY, LLC.
NORTHEAST SUPPLY ENHANCEMENT PROJECT
PROPOSED 26" MADISON LOOP
3.43 MI. - M.P. 8.57 TO M.P. 12.00
GROUNDWATER ELEVATION CONTOUR MAP
MIDDLESEX COUNTY, NEW JERSEY

Williams. GAS PIPELINE

DRAWN BY: PPH	DATE: 01/31/2018	ISSUED FOR BID: TBD		SCALE: 1" = 500'	
CHECKED BY: MO	DATE: 01/31/2018	ISSUED FOR CONSTRUCTION: TBD		REVISION: 0	
APPROVED BY: HB	DATE: 1	DRAWING NUMBER:	Figure 5	SHEET 01 OF 1	
W.O.					

Drawn By & Date/Time: hoasp Feb 01, 2018 – 10:00am
Drawing Location & Name: S:\Projects\ENV\60552906_NESE_Water\400-Technical\431- Dewatering\CAD\00 - Madison Dewatering_Groundwater.dwg



MADISON LOOP
1/4 MILE BUFFER
TOWNSHIP / BOROUGH BOUNDARY
DOMESTIC WELLS
INDUSTRIAL WELLS
PUBLIC COMMUNITY WELLS

NOTES:
1. USGS MAP FROM 7.5' QUADRANGLE, SOUTH AMBOY, NJ-NY 2014.

2,000' 1,000' 0' 2,000'

SCALE: 1" = 2,000'

AECOM
625 WEST RIDGE PIKE, SUITE E-100
CONSHOHOCKEN, PA 19428
(610) 832-3500

REVISIONS

NO.	DATE	BY	DESCRIPTION	W.O. NO.	CHK.	APP.

TRANSCONTINENTAL GAS PIPE LINE COMPANY, LLC.
NORTHEAST SUPPLY ENHANCEMENT PROJECT
PROPOSED 26" MADISON LOOP
FIGURE 6
WELL SEARCH MAP
MIDDLESEX COUNTY, NEW JERSEY

Williams.
GAS PIPELINE

DRAWN BY: PPH	DATE: 02/26/2018	ISSUED FOR BID: TBD		SCALE: 1" = 1,000'	
CHECKED BY: MO	DATE: 02/26/2018	ISSUED FOR CONSTRUCTION: TBD		REVISION: 0	
APPROVED BY: HB	DATE: 02/26/2018	DRAWING NUMBER:		SHEET 1 OF 1	
WO:					

Drawn By & Date/Time: haasp Feb 27, 2018 – 2:53pm
Drawing Location & Name: C:\Project Files\Williams\Madison\Dewatering\00 – Madison Dewatering_Figure 6.dwg

Tables

Table 1 - Summary of Linear Project (Old Bridge Township)

Station ID	EL (ft msl)	Municipality	State Well Permit No.	Location Description	Geological Formation	Length, ft	Excavation Depth, ft
99 +23	90.5	Old Bridge	N/A	Trench	Pennsauken (Tb)	77	7
100 +00	93.3	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7
101 +00	92.0	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7
102 +00	93.3	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7
103 +00	92.1	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7
104 +00	83.5	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7
105 +00	79.5	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7
106 +00	81.5	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7
107 +00	75.3	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7
108 +00	69.3	Old Bridge	N/A	Trench	Magothy (K)	100	7
109 +00	60.6	Old Bridge	N/A	Trench	Alluvium (Qal)	100	7
110 +00	61.0	Old Bridge	N/A	Trench	Alluvium (Qal)	100	7
111 +00	63.8	Old Bridge	N/A	Trench	Magothy (K)	100	7
112 +00	64.1	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7
113 +00	68.9	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7
114 +00	72.0	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7
115 +00	72.4	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7
116 +00	72.2	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7
117 +00	84.8	Old Bridge	N/A	Trench	Pennsauken (Tb)	89	7
117 +89	84.8	Old Bridge	N/A	HDD Entry Pit	Pennsauken (Tb)	11	12
118 +00	71.7	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---
119 +00	79.5	Old Bridge	N/A	HDD	Magothy (K)	100	---
120 +00	66.0	Old Bridge	N/A	HDD	Magothy (K)	100	---
121 +00	65.0	Old Bridge	N/A	HDD	Alluvium (Qal)	100	---
122 +00	62.7	Old Bridge	N/A	HDD	Alluvium (Qal)	100	---
123 +00	61.9	Old Bridge	N/A	HDD	Alluvium (Qal)	100	---
124 +00	66.2	Old Bridge	N/A	HDD	Magothy (K)	100	---
125 +00	74.0	Old Bridge	N/A	HDD	Magothy (K)	100	---
126 +00	73.1	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---
127 +00	74.9	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---
128 +00	81.4	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---
129 +00	87.0	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---
130 +00	83.8	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---
131 +00	76.5	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---
132 +00	74.3	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---
133 +00	68.2	Old Bridge	N/A	HDD	Alluvium (Qal)	100	---
134 +00	69.0	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---
135 +00	72.3	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---
136 +00	80.6	Old Bridge	N/A	HDD	Magothy (K)	89	---
136 +89	80.6	Old Bridge	N/A	HDD Exit Pit	Magothy (K)	11	12
137 +00	83.2	Old Bridge	N/A	Trench	Magothy (K)	100	7
138 +00	86.5	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7
139 +00	83.2	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7
140 +00	91.2	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7
141 +00	96.0	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7
142 +00	89.4	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7
143 +00	88.2	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7
144 +00	87.9	Old Bridge	N/A	Trench	Pennsauken (Tb)	47	7

Table 1 - Summary of Linear Project (Old Bridge Township)

Station ID	EL (ft msl)	Municipality	State Well Permit No.	Location Description	Geological Formation	Length, ft	Excavation Depth, ft
144 +47	87.0	Old Bridge	N/A	HDD Entry Pit	Pennsauken (Tb)	15	12
144 +62	87.0	Old Bridge	N/A	HDD	Pennsauken (Tb)	38	---
145 +00	86.8	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---
146 +00	85.2	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---
147 +00	84.8	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---
148 +00	86.7	Old Bridge	N/A	HDD	Magothy (K)	100	---
149 +00	88.8	Old Bridge	N/A	HDD	Magothy (K)	100	---
150 +00	95.6	Old Bridge	N/A	HDD	Magothy (K)	100	---
151 +00	95.8	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---
152 +00	98.2	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---
153 +00	103.0	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---
154 +00	107.0	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---
155 +00	110.0	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---
156 +00	113.0	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---
157 +00	114.7	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---
158 +00	116.0	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---
159 +00	115.7	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---
160 +00	116.6	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---
161 +00	118.0	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---
162 +00	121.0	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---
163 +00	122.7	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---
164 +00	123.0	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---
165 +00	121.4	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---
166 +00	111.9	Old Bridge	N/A	HDD	Magothy (K)	100	---
167 +00	116.8	Old Bridge	N/A	HDD	Magothy (K)	100	---
168 +00	119.4	Old Bridge	N/A	HDD	Magothy (K)	60	---
168 +60	121.0	Old Bridge	N/A	HDD Exit Pit	Magothy (K)	15	12
168 +75	121.0	Old Bridge	N/A	Trench	Magothy (K)	25	7
169 +00	122.0	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7
170 +00	126.7	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7
171 +00	126.6	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7
172 +00	122.7	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7
173 +00	90.6	Old Bridge	N/A	Trench	Magothy (K)	100	7
174 +00	51.4	Old Bridge	N/A	Trench	Magothy (K)	100	7
175 +00	27.9	Old Bridge	N/A	Trench	Magothy (K)	100	7
176 +00	21.1	Old Bridge	N/A	Trench	Magothy (K)	100	12
177 +00	18.5	Old Bridge	N/A	Trench	Magothy (K)	100	7
178 +00	17.7	Old Bridge	N/A	Trench	Magothy (K)	100	7
179 +00	17.7	Old Bridge	N/A	Trench	Magothy (K)	100	7
180 +00	19.7	Old Bridge	N/A	Trench	Magothy (K)	100	7
181 +00	19.2	Old Bridge	N/A	Trench	Magothy (K)	100	7
182 +00	18.1	Old Bridge	N/A	Trench	Magothy (K)	100	7
183 +00	19.3	Old Bridge	N/A	Trench	Magothy (K)	100	7
184 +00	19.3	Old Bridge	N/A	Trench	Magothy (K)	100	7
185 +00	18.0	Old Bridge	N/A	Trench	Magothy (K)	100	7
186 +00	18.1	Old Bridge	N/A	Trench	Magothy (K)	100	7
187 +00	17.2	Old Bridge	N/A	Trench	Magothy (Kma)	100	7
188 +00	16.4	Old Bridge	N/A	Trench	Magothy (Kma)	100	7

Table 1 - Summary of Linear Project (Old Bridge Township)

Station ID	EL (ft msl)	Municipality	State Well Permit No.	Location Description	Geological Formation	Length, ft	Excavation Depth, ft
189 +00	17.4	Old Bridge	N/A	Trench	Magothy (Kma)	100	12
190 +00	19.0	Old Bridge	N/A	Trench	Magothy (Kma)	100	7
191 +00	21.8	Old Bridge	N/A	Trench	Magothy (Kma)	100	7
192 +00	29.4	Old Bridge	N/A	Trench	Magothy (Kma)	100	7
193 +00	31.0	Old Bridge	N/A	Trench	Magothy (K)	30	7
193 +30	31.6	Old Bridge	N/A	Trench	Magothy (K)	0	7
					Total Length	9407	

HDD Horizontal Direction Drill
GPDB Garden State Parkway Directional Bore
GDDB Godenk Drive Directional Bore
OSDB Old Spye Road Directional Bore
The assigned geological formations are consistent with Figure 2

Table 2

Sites with Confirmed Contamination within a 1/4-mile radius of Northeast Supply Enhancement (NESE) Project - Madison Loop

Site Name	Municipality	Source	Distance from Pipeline	Direction from Pipeline	Position of Pipeline Relative to Identified Site	Geological Fm. Impacted	Site Status	Site ID No.
			miles					
Reclamations Technologies Inc.	Old Bridge	NJDEP DataMiner and GeoWeb	>0.1	West	Upgradient	Magothy Fm.	active	NJDEP Site Remediation Program PI ID #129931
Road Department Garage Area 3-1	Old Bridge	NJ Release, NJ Brownfields	<0.1	North	Downgradient	Pennsauken Fm., Magothy Fm.	active	NJDEP Site Remediation Program PI ID #012743
Global Sanitary Landfill Superfund Site	Old Bridge	NPL	<0.1	South	Upgradient	Magothy Fm.	active	EPA ID #NJD063160667
Global Sanitary Landfill CEA	Old Bridge	NJDEP DataMiner and Geoweb	<0.1	South	Downgradient	Magothy Fm.	active	EPA ID #NJD063160667
E I Dupont Nemours Co. CEA	Old Bridge	NJDEO DataMiner and Geoweb	<0.1	North and South	Upgradient and Downgradient	Magothy Fm.	active	NJDEP Site Remediation Program PI ID #008222

FUDS – Formerly Used Defense Sites. The Department of Defense is responsible for the environmental restoration of properties that were formerly owned by, leased to, or otherwise possessed by the United States and are under the jurisdiction of the Secretary of Defense prior to October 1986.

New Jersey Brownfields – Brownfields sites are identified as former or current commercial or industrial use sites that are presently vacant or underutilized on which there is suspected to have been a discharge of contamination to the soil or groundwater at concentrations greater than the applicable cleanup criteria.

New Jersey Release – New Jersey Hazardous Material Release database is a record of the initial notification information reported to the NJDEP's Action Line.

New Jersey Spill – All HazMat known or unknown spills to the ground reported to the NJ DEP's Action Line.

NPL – National Priority List database, also known as Superfund, is a subset of Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) and identifies over 1,200 sites for priority cleanup under the Superfund program. The source of this database is the United States Environmental Protection Agency.

SHWS/HIST HWS - State Hazardous Waste Sites/Historic Hazardous Waste Sites – Known Contaminated Sites in New Jersey database is a municipal listing of sites where contamination of soil and/or groundwater is confirmed at levels greater than the applicable cleanup criteria or standards. Remedial activities are under way or required at the sites with an on-site source(s) of contamination and at locations where the source(s) of contamination are unknown. Sites with completed remedial work that require engineering and/or institutional controls have reporting measures in place to ensure the effectiveness of past actions, and some include maintenance and/or monitoring.

Table 3 - 1/4-Mile Well Search Results

Northeast Supply Enhancement (NESE) - Madison Loop (Old Bridge Township)

NJDEP Doc ID	Activity_ID	Municipality	Loc_Type	Well_Type	Permit_No	Local Well ID	Status	X_Coord (ft)	Y_Coord (ft)	Diversion ID
Int_doc_id	Activity_i	---	Subject__1	Subject__2	Subject__3	Subject__4	Status_des	Spc83x	Spc83y	Sicc_siid
3788094	WPN470003	Old Bridge	Well	Domestic	2900000003			547,898	588,228	WSWL_746083
14747860	WAR110036	Old Bridge	Well	Domestic	2900000019	#1	Active	547,898	588,228	WSWL_746099
3788203	WPN490001	Old Bridge	Well	Industrial	2900000036			547,898	588,228	WSWL_746114
14700026	WAR110012	Old Bridge	Well	Domestic	2900002671	1	Active	547,387	586,236	WSWL_720286
14700161	WAR110013	Old Bridge	Well	Domestic	2900002778	1	Active	547,387	586,236	WSWL_720390
3698542	WPN590002	Old Bridge	Well	Domestic	2900002840			546,896	586,809	WSWL_720452
14722992	WAR110042	Old Bridge	Well	Domestic	2900003817		Active	548,977	589,546	WSWL_703250
3596563	WPN650091	Old Bridge	Well	Domestic	2900004749			542,801	585,485	WSWL_692141
14722947	WAR112320	Old Bridge	Well	Industrial	2900008130	#1	Active	542,804	584,169	WSWL_66336
14814698	WAR110174	Old Bridge	Well	Industrial	2900015345		Active	543,341	586,093	WSWL_552722

Column titles (2nd row) in gray are the original field names of the shape file received from NJDEP on February 20, 2018.
The original shape file (as received on February 20, 2018) was edited in order to remove obvious duplicate entries.
The true field locations of these wells were not verified independently, either by AECOM or Transco.
Figure 6 shows the locations (based on the X- and Y-coordinate fields) in relation to the linear extent of the Project, with each well labeled by its reported permit number.
The listing is sorted by well permit number.

Table 4 - Summary of Geotechnical Testing and Estimated Permeability

Loc ID	Sta. ID	S_EL	Municipality	Geological Formation	Depth, ft	Samp_EL	Description	Symbol	<#200 (%)	D_{90}, cm	D_{50}, cm	D_{10}, cm	$K = 100 (D_{10})^2$, cm/sec
CB-3	12110	66.3	Old Bridge	Magothy (K)	4-6	60.3-62.3	silty sand	SM	40	0.5	0.01	---	---
CB-3	12110	66.3	Old Bridge	Magothy (K)	20-22	44.3-46.3	silty sand	SM	19	0.03	0.02	---	---
CB-3	12110	66.3	Old Bridge	Magothy (K)	30-32	34.3-36.3	silt with sand	ML	77	---	---	---	---
CB-3	12110	66.3	Old Bridge	Magothy (K)	35-37	29.3-31.3	sand with silt	SP-SM	7	0.03	0.02	0.01	1.0E-02
CB-3	12110	66.3	Old Bridge	Magothy (K)	45-47	19.3-21.3	silty sand	SM	18	0.04	0.02	---	---
CB-3	12110	66.3	Old Bridge	Magothy (K)	55-57	9.3-11.3	silty sand	SM	23	0.035	0.02	---	---
CB-3	12110	66.3	Old Bridge	Magothy (K)	65-67	-0.7 - 1.3	sand with silt	SP-SM	9	0.04	0.025	0.01	1.0E-02
CB-3	12110	66.3	Old Bridge	Magothy (K)	75-77	-10.7 - -8.7	clay	CL	71	0.015	---	---	---
CB-3	12110	66.3	Old Bridge	Magothy (K)	80-82	-15.7 - -13.7	silty sand	SM	18	0.03	0.02	---	---
CB-3	12110	66.3	Old Bridge	Magothy (Kmo)	90-92	-25.7 - -23.7	sand with silt	SP-SM	9	0.07	0.025	0.008	6.4E-03
CB-3	12110	66.3	Old Bridge	Magothy (Kmo)	95-97	-30.7 - -28.7	silty sand	SM	48	0.015	0.007	---	---
CB-3	12110	66.3	Old Bridge	Magothy (Kmo)	110-112	-45.7 - -43.7	sand with silt	SP-SM	8	0.07	0.035	0.01	1.0E-02
CB-2	12510	69.1	Old Bridge	Magothy (K)	4-6	63.1-65.1	sand with silt	SP-SM	7	0.025	0.02	0.01	1.0E-02
CB-2	12510	69.1	Old Bridge	Magothy (K)	24-26	43.1-45.1	silty sand	SM	32	0.02	0.01	---	---
CB-2	12510	69.1	Old Bridge	Magothy (K)	68-70	-0.9 - 1.1	sand with silt	SP-SM	7	0.2	0.025	0.015	2.3E-02
AB-1	14610	84.9	Old Bridge	Magothy (K)	8-10	74.9-76.9	silty sand	SM	15	0.1	0.04	0.007	4.9E-03
AB-1	14610	84.9	Old Bridge	Magothy (K)	58-60	24.9-26.9	sandy silt	ML	87	0.02	---	---	---
AB-2	15310	105.2	Old Bridge	Magothy (K)	50-52	53.2-55.2	silty sand	SM	17	1	0.03	---	---
AB-2	15310	105.2	Old Bridge	Magothy (K)	55-57	48.2-50.2	silt	ML	86	0.01	---	---	---
AB-2	15310	105.2	Old Bridge	Magothy (K)	60-62	43.2-45.2	silt with sand	ML	71	2	---	---	---
AB-2	15310	105.2	Old Bridge	Magothy (K)	70-72	33.2-35.2	silty sand	SM	33	0.02	0.01	---	---
AB-2	15310	105.2	Old Bridge	Magothy (K)	75-77	28.2-30.2	sandy silt	ML	54	0.015	0.007	---	---
AB-2	15310	105.2	Old Bridge	Magothy (K)	80-82	23.2-25.2	clay	CL	81	0.015	---	---	---
AB-2	15310	105.2	Old Bridge	Magothy (K)	85-87	18.2-20.2	silt with sand	ML	82	0.01	---	---	---
AB-2	15310	105.2	Old Bridge	Magothy (K)	95-97	8.2-10.2	silty sand	SM	19	0.05	0.03	---	---
AB-3	16140	118.9	Old Bridge	Pennsauken	6-8	110.9-112.9	silty sand	SM	24	0.9	0.025	---	---
AB-3	16140	118.9	Old Bridge	Pennsauken	10-12	106.9-108.9	sandy clay	CL	60	0.025	---	---	---
AB-3	16140	118.9	Old Bridge	Magothy (K)	20-22	96.9-98.9	silty sand	SM	30	0.025	0.015	---	---
AB-3	16140	118.9	Old Bridge	Magothy (K)	30-32	86.9-88.9	silty sand	SM	16	0.035	0.02	---	---
AB-3	16140	118.9	Old Bridge	Magothy (K)	40-42	76.9-78.9	silty sand	SM	25	0.04	0.02	---	---
AB-3	16140	118.9	Old Bridge	Magothy (K)	50-52	66.9-68.9	silty sand	SM	27	0.04	0.02	---	---
AB-3	16140	118.9	Old Bridge	Magothy (K)	60-62	56.9-58.9	sand with silt	SP-SM	11	0.04	0.025	0.007	4.9E-03
AB-3	16140	118.9	Old Bridge	Magothy (K)	70-72	46.9-48.9	silty sand	SM	19	0.03	0.02	---	---
AB-3	16140	118.9	Old Bridge	Magothy (K)	75-77	41.9-43.9	silty sand	SM	25	0.02	0.015	---	---

Table 4 - Summary of Geotechnical Testing and Estimated Permeability

Loc ID	Sta. ID	S_EL	Municipality	Geological Formation	Depth, ft	Samp_EL	Description	Symbol	<#200 (%)	D_{90}, cm	D_{50}, cm	D_{10}, cm	K = 100 $(D_{10})^2$, cm/sec
AB-3	16140	118.9	Old Bridge	Magothy (K)	80-82	36.9-38.9	silty sand	SM	16	0.03	0.02	---	---
AB-3	16140	118.9	Old Bridge	Magothy (K)	90-92	26.9-28.9	silt	ML	91	0.008	---	---	---
AB-3	16140	118.9	Old Bridge	Magothy (K)	95-97	21.9-23.9	sandy silt	ML	69	0.018	---	---	---
AB-4	16790	120.2	Old Bridge	Magothy (K)	8-10	110.2-112.2	silty sand	SM	17	0.025	0.015	---	---
AB-4	16790	120.2	Old Bridge	Magothy (K)	29-31	89.2-91.2	sand with silt	SP-SM	12	0.05	0.03	0.007	4.9E-03
AB-4	16790	120.2	Old Bridge	Magothy (K)	83-85	35.2-37.2	silty sand	SM	31	0.035	0.02	---	---
B-1	17700	18.8	Old Bridge	Alluvium (Qal)	2-4	14.8-16.8	silty sand	SM	15	0.04	0.02	0.001	1.0E-04
B-1	17700	18.8	Old Bridge	Alluvium (Qal)	4-6	12.8-14.8	silty sand	SM	21	0.04	0.02	0.001	1.0E-04
B-1	17700	18.8	Old Bridge	Alluvium (Qal)	10-12	8.8-10.8	silty sand	SM	21	0.04	0.02	0.0004	1.6E-05
B-1	17700	18.8	Old Bridge	Magothy (K)	14-16	2.8-4.8	sand with silt	SW-SM	11	0.4	0.025	0.0035	1.2E-03
B-1	17700	18.8	Old Bridge	Magothy (K)	24-26	-7.2 - 2.8	silty sand	SM	14	0.07	0.035	0.002	4.0E-04
B-1	17700	18.8	Old Bridge	Magothy (Kmo)	34-36	-17.2 - -7.2	silty sand	SM	26	0.04	0.015	---	---
B-2	17741	15.8	Old Bridge	Alluvium (Qal)	4-6	9.8-11.8	silty sand	SM	13	0.04	0.02	0.002	4.0E-04
B-2	17741	15.8	Old Bridge	Alluvium (Qal)	8-10	5.8-7.8	sand and silt	SP-SM	9	0.04	0.02	0.008	6.4E-03
B-2	17741	15.8	Old Bridge	Magothy (K)	10-12	3.8-5.8	silty sand	SM	16	0.04	0.02	0.002	4.0E-04
B-2	17741	15.8	Old Bridge	Magothy (K)	14-16	-0.2 - 1.8	silty sand	SM	12	0.05	0.025	0.003	9.0E-04
B-2	17741	15.8	Old Bridge	Magothy (K)	19-21	-5.2 - 4.8	sand with silt	SP-SM	9	0.04	0.02	0.01	1.0E-02
B-2	17741	15.8	Old Bridge	Magothy (Kmo)	34-36	-20.2 - -10.2	sand with silt	SP-SM	10	0.03	0.015	0.008	6.4E-03
MDB-1	26920	10.5	Sayreville	Magothy (K)	19-21	-10.5 - -8.5	silty sand	SM	33	0.02	0.015	---	---
MDB-1	26920	10.5	Sayreville	Magothy (Kmo)	34-36	-25.5 - -23.5	sand with silt	SP-SM	9	0.025	0.02	0.008	6.4E-03
MDB-1	26920	10.5	Sayreville	Magothy (Kmo)	48-50	-39.5 - -37.5	sand with silt	SP-SM	7	0.04	0.025	0.015	2.3E-02
GB-2	24147	25.5	Sayreville	Magothy (K)	8-10	15.5-17.5	sand with silt	SP-SM	12	0.025	0.018	0.005	2.5E-03
GB-2	24147	25.5	Sayreville	Magothy (K)	14-16	9.5-11.5	sand with silt	SP-SM	5	0.04	0.022	0.015	2.3E-02
GB-2	24147	25.5	Sayreville	Magothy (K)	19-21	4.5-6.5	silty sand	SM	48	0.015	0.008	---	---
GB-2	24147	25.5	Sayreville	Magothy (K)	29-31	-5.5 - -3.5	silty sand	SM	36	2	0.01	---	---
GB-2	24147	25.5	Sayreville	Magothy (K)	33-35	-9.5 - -7.5	sand with silt	SP-SM	9	0.025	0.02	0.01	1.0E-02
GB-2	24147	25.5	Sayreville	Magothy (Kmo)	48-50	-24.5 - -22.5	sand with silt	SP-SM	8	0.03	0.02	0.01	1.0E-02
GB-3	23697	39.9	Sayreville	Fill	4-6	33.9-35.9	silty sand	SM	30	0.02	0.012	---	---
GB-3	23697	39.9	Sayreville	Magothy (Kma)	14-16	23.9-25.9	silty sand	SM	24	0.025	0.018	---	---
GB-3	23697	39.9	Sayreville	Magothy (Kma)	24-26	13.9-15.9	silty sand	SM	12	0.025	0.02	0.007	4.9E-03
GB-3	23697	39.9	Sayreville	Magothy (Kma)	33-35	4.9-6.9	clay	CL	90	0.007	---	---	---
GB-3	23697	39.9	Sayreville	Magothy (K)	48-50	-10.1 - -8.1	silty sand	SM	29	0.025	0.015	---	---
GB-4	23739	46.1	Sayreville	Fill	8-10	36.1-38.1	silty sand	SM	26	0.1	0.025	---	---
GB-4	23739	46.1	Sayreville	Fill	14-16	30.1-32.1	silty sand	SM	21	1	0.04	---	---

Table 4 - Summary of Geotechnical Testing and Estimated Permeability

Loc ID	Sta. ID	S_EL	Municipality	Geological Formation	Depth, ft	Samp_EL	Description	Symbol	<#200 (%)	D_{90}, cm	D_{50}, cm	D_{10}, cm	$K = 100 (D_{10})^2$, cm/sec
GB-4	23739	46.1	Sayreville	Fill	19-21	24.1-26.1	silty sand	SM	29	0.022	0.015	---	---
GB-4	23739	46.1	Sayreville	Fill	24-26	20.1-22.1	silty sand	SM	15	2	0.02	---	---
GB-4	23739	46.1	Sayreville	Magothy (K)	29-31	15.1-17.1	silty sand	SM	22	0.022	0.018	---	---
GB-4	23739	46.1	Sayreville	Magothy (K)	38-40	6.1-8.1	silty sand	SM	18	0.025	0.02	---	---
GB-4	23739	46.1	Sayreville	Magothy (Kmo)	63-65	-18.9 - -16.9	silty sand	SM	36	0.04	0.018	---	---
GB-5	23810	42.3	Sayreville	Magothy (Kma)	8-10	32.3-34.3	silty sand	SM	22	0.09	0.03	---	---
GB-5	23810	42.3	Sayreville	Magothy (Kma)	10-12	30.3-32.3	silty sand	SM	26	0.07	0.03	---	---
GB-5	23810	42.3	Sayreville	Magothy (Kma)	15-17	25.3-27.3	silty sand	SM	18	0.7	0.035	---	---
GB-5	23810	42.3	Sayreville	Magothy (Kma)	28-30	12.3-14.3	silty sand	SM	20	0.1	0.035	---	---
GB-5	23810	42.3	Sayreville	Magothy (K)	38-40	2.3-4.3	silty sand	SM	15	0.025	0.02	---	---
GB-5	23810	42.3	Sayreville	Magothy (Kmo)	58-60	-17.7 - -15.7	silty sand	SM	30	0.04	0.02	---	---
GB-7	23971	41.4	Sayreville	Fill	8-10	31.4-33.4	silty sand	SM	24	2	0.04	---	---
GB-7	23971	41.4	Sayreville	Fill	19-21	20.4-22.4	silty sand	SM	22	1.2	0.03	---	---
GB-7	23971	41.4	Sayreville	Magothy (Kma)	24-26	15.4-17.4	silty sand	SM	18	0.08	0.03	---	---
GB-7	23971	41.4	Sayreville	Magothy (Kma)	33-35	6.4-8.4	silty sand	SM	12	0.028	0.02	0.005	2.5E-03
GB-7	23971	41.4	Sayreville	Magothy (K)	53-55	-13.6 - -11.6	silty sand	SM	14	0.04	0.025	---	---

Table 4 - Summary of Geotechnical Testing and Estimated Permeability

USCS Symbol	SP	SP-SM	SW-SM	SM	ML	CL	Compounded Estimated K	
K (est), cm/sec	1.0E-01	2.5E-02	7.5E-03	2.5E-03	1.0E-04	1.0E-05		
K (est), ft/d	283	71	21	7	0.3	0.03	cm/sec	ft/d
Alluvium (Qal)	0	1	0	4	0	0	7.0E-03	20
Pennsauken	0	0	0	1	0	1	1.3E-03	3.6
Magothy (K)	0	6	1	24	7	1	5.6E-03	16
Magothy (Kma)	0	0	0	8	0	1	2.2E-03	6.3
Magothy (Kmo)	0	4	0	3	0	0	1.5E-02	44
total number of samples	*0*	*11*	*1*	*40*	*7*	*3*		

Table 5 - Estimated Dewatering Rates Along Project Extent (Old Bridge Township)

Station ID	EL (ft msl)	Municipality	State Well Permit No.	Location Description	Geological Formation	Length, ft	Excavation Depth, ft	Dewatering Anticipated?	Dewatering Rationale	Withdrawal Rate, gpm	Estimated Duration of Dewatering, days	Est. Max Withdrawal Rate (Mgal/mo)	Est. Max Withdrawal Rate (Mgal/yr)	Total Yield, Mgal	Total Yield, gal/ft
99 +23	90.5	Old Bridge	N/A	Trench	Pennsauken (Tb)	77	7	Yes	Perched water / wetland or stream	18.4	2	0.053	0.053	0.053	689
100 +00	93.3	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7	Yes	Perched water / wetland or stream	23.9	2	0.069	0.069	0.069	689
101 +00	92.0	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7	Yes	Perched water / wetland or stream	23.9	2	0.069	0.069	0.069	689
102 +00	93.3	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7	Yes	Perched water / wetland or stream	23.9	2	0.069	0.069	0.069	689
103 +00	92.1	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7	Yes	Perched water / wetland or stream	23.9	2	0.069	0.069	0.069	689
104 +00	83.5	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7	Yes	Perched water / wetland or stream	23.9	2	0.069	0.069	0.069	689
105 +00	79.5	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7	Yes	Perched water / wetland or stream	23.9	2	0.069	0.069	0.069	689
106 +00	81.5	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7	Yes	Perched water / wetland or stream	23.9	2	0.069	0.069	0.069	689
107 +00	75.3	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7	Yes	Perched water / wetland or stream	23.9	2	0.069	0.069	0.069	689
108 +00	69.3	Old Bridge	N/A	Trench	Magothy (K)	100	7	Yes	Perched water / wetland or stream	49.6	2	0.143	0.143	0.143	1428
109 +00	60.6	Old Bridge	N/A	Trench	Alluvium (Qal)	100	7	Yes	Perched water / wetland or stream	23.9	2	0.069	0.069	0.069	689
110 +00	61.0	Old Bridge	N/A	Trench	Alluvium (Qal)	100	7	Yes	Perched water / wetland or stream	23.9	2	0.069	0.069	0.069	689
111 +00	63.8	Old Bridge	N/A	Trench	Magothy (K)	100	7	Yes	Perched water / wetland or stream	49.6	2	0.143	0.143	0.143	1428
112 +00	64.1	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7	No	Pipe EL > GW Table, no perched water evidence	0.0	2	0.000	0.000	0.000	0
113 +00	68.9	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7	No	Pipe EL > GW Table, no perched water evidence	0.0	2	0.000	0.000	0.000	0
114 +00	72.0	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7	No	Pipe EL > GW Table, no perched water evidence	0.0	2	0.000	0.000	0.000	0
115 +00	72.4	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7	No	Pipe EL > GW Table, no perched water evidence	0.0	2	0.000	0.000	0.000	0
116 +00	72.2	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7	No	Pipe EL > GW Table, no perched water evidence	0.0	2	0.000	0.000	0.000	0
117 +00	84.8	Old Bridge	N/A	Trench	Pennsauken (Tb)	89	7	No	Pipe EL > GW Table, no perched water evidence	0.0	2	0.000	0.000	0.000	0
117 +89	84.8	Old Bridge	N/A	HDD Entry Pit	Pennsauken (Tb)	11	12	No	Pit EL > GW Table, no perched water evidence	0.0	7	0.000	0.000	0.000	0
118 +00	71.7	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
119 +00	79.5	Old Bridge	N/A	HDD	Magothy (K)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
120 +00	66.0	Old Bridge	N/A	HDD	Magothy (K)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
121 +00	65.0	Old Bridge	N/A	HDD	Alluvium (Qal)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
122 +00	62.7	Old Bridge	N/A	HDD	Alluvium (Qal)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
123 +00	61.9	Old Bridge	N/A	HDD	Alluvium (Qal)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
124 +00	66.2	Old Bridge	N/A	HDD	Magothy (K)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
125 +00	74.0	Old Bridge	N/A	HDD	Magothy (K)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
126 +00	73.1	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
127 +00	74.9	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
128 +00	81.4	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
129 +00	87.0	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
130 +00	83.8	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
131 +00	76.5	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
132 +00	74.3	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
133 +00	68.2	Old Bridge	N/A	HDD	Alluvium (Qal)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
134 +00	69.0	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
135 +00	72.3	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
136 +00	80.6	Old Bridge	N/A	HDD	Magothy (K)	89	---	No	HDD	0.0	0	0.000	0.000	0.000	0
136 +89	80.6	Old Bridge	N/A	HDD Exit Pit	Magothy (K)	11	12	No	Pit EL > GW Table, no perched water evidence	0.0	7	0.000	0.000	0.000	0
137 +00	83.2	Old Bridge	N/A	Trench	Magothy (K)	100	7	No	Pipe EL > GW Table, no perched water evidence	0.0	2	0.000	0.000	0.000	0
138 +00	86.5	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7	No	Pipe EL > GW Table, no perched water evidence	0.0	2	0.000	0.000	0.000	0
139 +00	83.2	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7	No	Pipe EL > GW Table, no perched water evidence	0.0	2	0.000	0.000	0.000	0
140 +00	91.2	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7	No	Pipe EL > GW Table, no perched water evidence	0.0	2	0.000	0.000	0.000	0
141 +00	96.0	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7	No	Pipe EL > GW Table, no perched water evidence	0.0	2	0.000	0.000	0.000	0
142 +00	89.4	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7	No	Pipe EL > GW Table, no perched water evidence	0.0	2	0.000	0.000	0.000	0
143 +00	88.2	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7	No	Pipe EL > GW Table, no perched water evidence	0.0	2	0.000	0.000	0.000	0
144 +00	87.9	Old Bridge	N/A	Trench	Pennsauken (Tb)	47	7	No	Pipe EL > GW Table, no perched water evidence	0.0	2	0.000	0.000	0.000	0
144 +47	87.0	Old Bridge	N/A	HDD Entry Pit	Pennsauken (Tb)	15	12	No	Pit EL > GW Table, no perched water evidence	0.0	7	0.000	0.000	0.000	0
144 +62	87.0	Old Bridge	N/A	HDD	Pennsauken (Tb)	38	---	No	HDD	0.0	0	0.000	0.000	0.000	0
145 +00	86.8	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
146 +00	85.2	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
147 +00	84.8	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
148 +00	86.7	Old Bridge	N/A	HDD	Magothy (K)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
149 +00	88.8	Old Bridge	N/A	HDD	Magothy (K)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
150 +00	95.6	Old Bridge	N/A	HDD	Magothy (K)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0

Table 5 - Estimated Dewatering Rates Along Project Extent (Old Bridge Township)

Station ID	EL (ft msl)	Municipality	State Well Permit No.	Location Description	Geological Formation	Length, ft	Excavation Depth, ft	Dewatering Anticipated?	Dewatering Rationale	Withdrawal Rate, gpm	Estimated Duration of Dewatering, days	Est. Max Withdrawal Rate (Mgal/mo)	Est. Max Withdrawal Rate (Mgal/yr)	Total Yield, Mgal	Total Yield, gal/ft
151 +00	95.8	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
152 +00	98.2	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
153 +00	103.0	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
154 +00	107.0	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
155 +00	110.0	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
156 +00	113.0	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
157 +00	114.7	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
158 +00	116.0	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
159 +00	115.7	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
160 +00	116.6	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
161 +00	118.0	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
162 +00	121.0	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
163 +00	122.7	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
164 +00	123.0	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
165 +00	121.4	Old Bridge	N/A	HDD	Pennsauken (Tb)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
166 +00	111.9	Old Bridge	N/A	HDD	Magothy (K)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
167 +00	116.8	Old Bridge	N/A	HDD	Magothy (K)	100	---	No	HDD	0.0	0	0.000	0.000	0.000	0
168 +00	119.4	Old Bridge	N/A	HDD	Magothy (K)	60	---	No	HDD	0.0	0	0.000	0.000	0.000	0
168 +60	121.0	Old Bridge	N/A	HDD Exit Pit	Magothy (K)	15	12	No	Pit EL > GW Table, no perched water evidence	0.0	7	0.000	0.000	0.000	0
168 +75	121.0	Old Bridge	N/A	Trench	Magothy (K)	25	7	No	Pipe EL > GW Table, no perched water evidence	0.0	2	0.000	0.000	0.000	0
169 +00	122.0	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7	No	Pipe EL > GW Table, no perched water evidence	0.0	2	0.000	0.000	0.000	0
170 +00	126.7	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7	No	Pipe EL > GW Table, no perched water evidence	0.0	2	0.000	0.000	0.000	0
171 +00	126.6	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7	No	Pipe EL > GW Table, no perched water evidence	0.0	2	0.000	0.000	0.000	0
172 +00	122.7	Old Bridge	N/A	Trench	Pennsauken (Tb)	100	7	No	Pipe EL > GW Table, no perched water evidence	0.0	2	0.000	0.000	0.000	0
173 +00	90.6	Old Bridge	N/A	Trench	Magothy (K)	100	7	No	Pipe EL > GW Table, no perched water evidence	0.0	2	0.000	0.000	0.000	0
174 +00	51.4	Old Bridge	N/A	Trench	Magothy (K)	100	7	No	Pipe EL > GW Table, no perched water evidence	0.0	2	0.000	0.000	0.000	0
175 +00	27.9	Old Bridge	N/A	Trench	Magothy (K)	100	7	Yes	Pipe EL < GW Table, or proximal to GW Table	49.6	2	0.143	0.143	0.143	1428
176 +00	21.1	Old Bridge	N/A	Trench	Magothy (K)	100	12	Yes	Pipe EL < GW Table, or proximal to GW Table	47.3	2	0.136	0.136	0.136	1362
177 +00	18.5	Old Bridge	N/A	Trench	Magothy (K)	100	7	Yes	Pipe EL < GW Table, or proximal to GW Table	49.6	2	0.143	0.143	0.143	1428
178 +00	17.7	Old Bridge	N/A	Trench	Magothy (K)	100	7	Yes	Pipe EL < GW Table, or proximal to GW Table	49.6	2	0.143	0.143	0.143	1428
179 +00	17.7	Old Bridge	N/A	Trench	Magothy (K)	100	7	Yes	Pipe EL < GW Table, or proximal to GW Table	49.6	2	0.143	0.143	0.143	1428
180 +00	19.7	Old Bridge	N/A	Trench	Magothy (K)	100	7	Yes	Pipe EL < GW Table, or proximal to GW Table	49.6	2	0.143	0.143	0.143	1428
181 +00	19.2	Old Bridge	N/A	Trench	Magothy (K)	100	7	Yes	Pipe EL < GW Table, or proximal to GW Table	49.6	2	0.143	0.143	0.143	1428
182 +00	18.1	Old Bridge	N/A	Trench	Magothy (K)	100	7	Yes	Pipe EL < GW Table, or proximal to GW Table	49.6	2	0.143	0.143	0.143	1428
183 +00	19.3	Old Bridge	N/A	Trench	Magothy (K)	100	7	Yes	Pipe EL < GW Table, or proximal to GW Table	49.6	2	0.143	0.143	0.143	1428
184 +00	19.3	Old Bridge	N/A	Trench	Magothy (K)	100	7	Yes	Pipe EL < GW Table, or proximal to GW Table	49.6	2	0.143	0.143	0.143	1428
185 +00	18.0	Old Bridge	N/A	Trench	Magothy (K)	100	7	Yes	Pipe EL < GW Table, or proximal to GW Table	49.6	2	0.143	0.143	0.143	1428
186 +00	18.1	Old Bridge	N/A	Trench	Magothy (K)	100	7	Yes	Pipe EL < GW Table, or proximal to GW Table	49.6	2	0.143	0.143	0.143	1428
187 +00	17.2	Old Bridge	N/A	Trench	Magothy (Kma)	100	7	Yes	Pipe EL < GW Table, or proximal to GW Table	13.5	2	0.039	0.039	0.039	388
188 +00	16.4	Old Bridge	N/A	Trench	Magothy (Kma)	100	7	Yes	Pipe EL < GW Table, or proximal to GW Table	13.5	2	0.039	0.039	0.039	388
189 +00	17.4	Old Bridge	N/A	Trench	Magothy (Kma)	100	12	Yes	Pipe EL < GW Table, or proximal to GW Table	12.0	2	0.035	0.035	0.035	347
190 +00	19.0	Old Bridge	N/A	Trench	Magothy (Kma)	100	7	Yes	Pipe EL < GW Table, or proximal to GW Table	13.5	2	0.039	0.039	0.039	388
191 +00	21.8	Old Bridge	N/A	Trench	Magothy (Kma)	100	7	Yes	Pipe EL < GW Table, or proximal to GW Table	13.5	2	0.039	0.039	0.039	388
192 +00	29.4	Old Bridge	N/A	Trench	Magothy (Kma)	100	7	Yes	Pipe EL < GW Table, or proximal to GW Table	13.5	2	0.039	0.039	0.039	388
193 +00	31.0	Old Bridge	N/A	Trench	Magothy (K)	30	7	No	Pipe EL > GW Table, no perched water evidence	0.0	2	0.000	0.000	0.000	0
193 +30	31.6	Old Bridge	N/A	Trench	Magothy (K)	0	7	No	Pipe EL > GW Table, no perched water evidence	0.0	0	0.000	0.000	0.000	0
					Total Length	9407					134			2.96	315

HDD Horizontal Direction Drill
GSDB Garden State Parkway Directional Bore
GDDB Godenk Drive Directional Bore
OSDB Old Spye Road Directional Bore
The assigned geological formations are consistent with Figure 2

Appendix A

Geotechnical Investigation Reports

AECOM

SUMMARY OF FINDINGS
GEOTECHNICAL INVESTIGATION FOR
NORTHEAST SUPPLY ENHANCEMENT – MADISON LOOP
Middlesex County, New Jersey
(Dated October 13, 2017)

1. BACKGROUND

Transcontinental Gas Pipe Line Company, LLC (Transco) is planning approximately 3.4 miles of 26-inch looping in Middlesex County, New Jersey designated as Madison Loop (Site) as a part of its Northeast Supply Enhancement project. Site location is presented on **Figure 1**.

Transco previously authorized AECOM to complete geotechnical investigation work to characterize subsurface conditions along the planned pipeline alignment. In this regard, Transco requested AECOM to complete nine borings to provide subsurface information including the information desired by Laney Directional Drilling Company (Laney) to complete the horizontal directional drilling (HDD) design for Transco. AECOM therefore coordinated with Transco and Laney to identify the desired boring locations and sampling requirements, and subsequently completed all borings and associated laboratory testing. Findings of this subsurface investigation are further described below.

2. REGIONAL GEOLOGY

2.1 - Bedrock Geology

The crystalline bedrock basement underlying the Site consists of lower Paleozoic and Precambrian schist and gneiss. The elevation of the bedrock surface ranges from 275 to 325 feet below sea level (Sandberg, 1996) (Reference 1).

2.2 - Surficial Geology

The material overlying basement rock at the Site consists of a discontinuous overburden of Tertiary and Quaternary deposits atop southeast dipping Cretaceous units (members of Magothy and Raritan Formations) which may outcrop at the surface. The units present at the Site are listed below in order of youngest to oldest.

The elevation of the top of the Old Bridge Sand unit ranges from -20 to -30 feet NGVD 1929; the thickness of the Old Bridge Sand unit ranges 65 to 75 feet; and the elevation of the top of the Farrington Sand member is about -180 feet NGVD 1929. Each of the members of the Cliffwood beds, Morgan beds, and Amboy Stoneware Clay may be difficult to distinguish and are at times mapped as a combined undivided Magothy unit. These characteristics of the regional geology are used to identify strata in the borings (References 1 through 5).

- Holocene salt marsh/estuarine deposits - Silt, sand, peat, clay, minor pebble gravel; brown, dark-brown, gray, black; as much as 100 feet thick; contain abundant organic matter

- Holocene and late Pleistocene alluvium – Sand, gravel, silt, minor clay and peat; reddish brown, yellowish brown, brown, gray; as much as 20 feet thick; variable amounts of organic matter
- Middle to late Pleistocene upper stream terrace deposits - Sand and pebble gravel, minor silt and cobble gravel; yellow, reddish yellow, yellowish brown; as much as 20 feet thick
- Pleistocene (locally Miocene and Pliocene) weathered Cretaceous deposits - Exposed sand and clay of Cretaceous formations; includes thin, patchy alluvium and colluvium, and pebbles left from erosion of surficial deposits
- Pliocene Pennsauken Formation - Sand, clayey sand, pebble gravel, minor silt, clay, and cobble gravel; yellow, reddish yellow, white; locally iron-cemented; as much as 140 feet thick.
- Pliocene Glauconitic phase of Pennsauken Formation - Sand, clayey sand, and pebble gravel, minor silt and clay; reddish yellow to yellowish brown; sand typically includes glauconite; as much as 40 feet thick
- Cretaceous Cliffwood beds (Magothy) – Fine to medium quartz sand; white, yellow, gray; interbedded with thin, dark gray, micaceous, carbonaceous silt with pyrite; as much as 40 feet thick
- Cretaceous Morgan beds (Magothy) - Laminated to thinly interbedded clay (light to medium gray, typically carbonaceous) and micaceous quartz sand (white, yellow, and light gray); sand is predominantly fine grained, massive to cross-bedded; as much as 90 feet thick
- Cretaceous Amboy Stoneware Clay (Magothy) - Dark gray to grayish-brown clay and silt which weathers to white; carbonaceous and micaceous with grayish-pink fine quartz sand laminae; as much as 30 feet thick
- Cretaceous Old Bridge Sand unit (Magothy) - Light gray quartz sand weathered to white, yellow and pink with occasional clear mica and lignite; interbedded with dark gray, discontinuous, carbonaceous clay beds as much as 3 feet thick; unit as much as 100 feet thick
- Cretaceous South Amboy Fire Clay (Magothy) - Massive to laminated clay, locally dark gray but typically oxidized to white and red; as much as 30 feet thick
- Cretaceous Sayreville Sand (Raritan) - Fine to medium sand locally thin and clayey; has an average thickness of 35 to 40 feet
- Cretaceous Woodbridge Clay (Raritan) - Dark gray, massive clay and silt unit with mica, fine-grained wood, and pyrite; occasionally interlaminated with light gray to white sand; commonly contains gray to brown siderite; as much as 110 feet thick
- Cretaceous Farrington Sand (Raritan) - White, yellow, red, light gray micaceous quartz sand commonly interbedded with thin gravel beds and thin to thick dark gray silt beds; as much as 50 feet thick (Stanford, 1993).

3. SUBSURFACE INVESTIGATION

Nine geotechnical test borings and laboratory testing were completed as further described below.

3.1 - Test Borings

Subsurface conditions were explored by completing nine (9) geotechnical test borings, designated borings AB-1, AB-2, AB-3, AB-4, CB-1, CB-2, CB-3, MB-1 and MDB-1, at the approximate locations shown on **Figure 2**.

Prior to initiating the test boring work, AECOM obtained NJDEP well permits for the test borings with the termination depth of 50 feet or greater (i.e., all borings except boring MB-1) and completed a utility notification through the New Jersey One-Call system to provide for mark-out of any known public utilities.

Uni-Tech Drilling Co., Inc. of Franklinville, New Jersey completed the test borings under a subcontract to AECOM between September 15, 2016 and August 23, 2017. The borings were drilled using a rubber-tire-mounted CME-750 and a track-mounted CME-55 ATV drill rigs. Key findings of the test borings are summarized in **Table 1** and no bedrock was encountered in any of the nine borings until its termination depth. Logs of the test borings are presented in **Appendix A**.

The test borings were advanced using hollow stem auger (HSA) and rotary wash soil drilling techniques. Within each test boring, representative samples were collected from the encountered overburden soils using a 24-inch-long split-spoon sampler (2-inch O.D.) driven with a 140-pound hammer freely falling 30 inches in accordance with ASTM D-1586 ("Penetration Test and Split-Barrel Sampling of Soils"). In general, representative samples of the soil materials encountered in the test borings were collected at continuous depth intervals to approximately 12 feet below existing ground surface (bgs) and at five-foot depth intervals thereafter.

The collected split-spoon soils samples were preserved and labeled in accordance with industry standards. Soil samples were subsequently transported to the AECOM geotechnical laboratory in Conshohocken, Pennsylvania for further examination and testing.

Organic vapor monitoring was also conducted during the test boring operations by an AECOM field representative using a MiniRAE Photoionization Detector (PID) monitor. Upon completion, each borehole was backfilled with a cement-bentonite grout to original ground surface as an environmental safeguard. The grout was placed using a tremie pipe placed at the bottom of the borehole. All excess soil cuttings and drilling fluids produced from test borings were containerized into drums, staged at each borehole location, and hauled to an onsite drum staging area designated by Transco. All field activities were completed under the full-time technical supervision of an AECOM field professional.

3.2 - Survey of Boring Locations

Transco surveyed the planned and completed locations of each boring. The completed location of each boring is shown on **Figure 2**. Coordinates and ground surface elevations at each boring are provided in **Table 1** and the boring logs in **Appendix A**.

3.3 - Laboratory Testing Program

Geotechnical laboratory testing was completed on representative samples of the encountered soil materials. Results of the testing program are presented in **Appendix B**.

Selected split-spoon soil samples were tested for physical properties including natural moisture content (ASTM D-2216), grain-size distribution (ASTM D-421/422) and plasticity by Atterberg limits (ASTM D-4318) to assist in classifying the encountered soils and evaluating stratigraphical continuity. A table summarizing the soil testing results for these soil samples is presented on pages B-1 through B-3. Grain-size distribution curves are presented on pages B-4 through B-20.

4. SUBSURFACE CONDITIONS

AECOM identified distinct soil strata and apparent stratigraphical conditions as inferred by the soil materials encountered in the test borings and measured in the laboratory. Inferred subsurface profiles were developed and are presented on **Figures 3-1** and **3-2**. Detailed soil descriptions presented in the boring logs of **Appendix A** are summarized below (presented in order of increasing depth):

4.1 Stratum 1 – Fill

Fill materials were only encountered within the upper 2 feet of boring MB-1, consisting predominately of silty sand with gravel. Standard penetration resistance (or N-) value was 21 blows per foot (bpf), which is indicative of very dense conditions.

4.2 Stratum 2 – Undivided Magothy Unit

Stratum 2 was observed in all borings except boring MB-1, consisting predominately of silty sand and silty to sandy clay. This unit was observed to be approximately 32 to 95 feet thick. Stratum 2 starts from ground surface or underlies Stratum 3, Pennsauken Formation described below.

Stratum 2 soils were observed to be typically medium dense to dense (for sandy soils) or stiff to very stiff (for clayey soils). N-values ranged from weight-of-hammer (WOH) to split-spoon refusal (e.g., 50 blows per 3 inches sampling advancement). Gravel content was found to range from approximately zero to 14 percent. Atterberg limit testing indicated liquid limits ranging from 29 to 45 and plasticity indices ranging from 12 to 21, indicating Stratum 2 soils are medium-plastic.

4.3 Stratum 3 – Pennsauken Formation

Stratum 3 was observed in borings AB-2, AB-3 and CB-2, consisting predominately of silty sand with gravel. This unit was observed to be approximately 2 to 39 feet thick. Stratum 3 consistently starts from ground surface and overlies Stratum 2 where encountered.

Stratum 3 soils were observed to be loose to dense and N-values of Stratum 3 soils ranged from 3 to 17 bpf. Gravel content was found to be approximately 15 percent.

4.4 Stratum 4 – Old Bridge Sand

Stratum 4 was observed in borings CB-1, CB-2, CB-3 and MDB-1, consisting predominately of silty sand with interbedded silty clay. This unit was not fully penetrated by any of the four borings above so its thickness is unknown. Stratum 4 consistently underlies Stratum 2 where encountered.

Stratum 4 soils were observed to be medium dense to very dense and N-values of Stratum 4 soils ranged from 11 bpf to split-spoon refusal (e.g., 50 blows per 4 inches sampling advancement). No gravel was encountered in this stratum.

4.5 Stratum 5 – Amboy Stoneware Clay

Stratum 5 soils were encountered within boring MB-1 only, consisting predominately of silty clay. N-values ranged from 4 to 9 bpf. Unconfined compressive strength of these soils, as measured in the field with a pocket penetrometer, ranged from 1.0 to 2.5 tons per square foot (tsf), which indicates a stiff to very stiff consistency.

4.6 Groundwater

Groundwater levels were measured during drilling and were recorded in the boring logs presented in **Appendix A**. Collected groundwater level information is summarized in **Table 1**.

As shown on **Table 1**, groundwater was encountered during drilling with depths ranging from approximately 4 to 55 feet bgs (between approximate elevations 3 and 111 feet). It should be noted that groundwater levels are subject to change due to seasonal conditions and man-made influences.

5. REFERENCES

1) Sandberg, S.K., D.W. Hall, J.A.M. Gronberg, and D.L. Pasicznyk. 1996. Geophysical Investigations of the Potomac-Raritan-Magothy Aquifer System and Underlying Bedrock in Parts of Middlesex and Mercer Counties, New Jersey. New Jersey Geological Survey Report GSR 37.

2) Farlekas, G. M. 1979. Geohydrology and Digital-simulation Model of the Farrington Aquifer in the Northern Coastal Plain of New Jersey. United States Geological Survey Water-Resources Investigations 79-106.

3) Gronberg, JM., A.A. Pucci, Jr., and B.A. Birkelo. 1991. Hydrogeologic Framework of the Potomac-Raritan-Magothy Aquifer System, Northern Coastal Pan of New Jersey. United States Geological Survey Water-Resources Investigations Report 90-4016.

4) New Jersey Department of Environmental Protection. Bureau of GIS. NJ-GeoWEB. Accessed Oct 2017.

5) Sugarman, P.J., S.D. Stanford, J.P. Owens, and G.J. Brenner. 2005. Bedrock Geology of the South Amboy Quadrangle, Middlesex and Monmouth Counties, New Jersey. New Jersey Geological Survey Open File Map OFM 65.

6. LIMITATIONS

The geotechnical investigation work completed by AECOM was performed in accordance with reasonable and accepted engineering practices. No warranty or guarantee, either written or implied, is applicable to this work. The findings presented in this report are based on the assumption that the subsurface conditions do not deviate appreciably from those disclosed by the test borings.

This report has been prepared solely for use by Transcontinental Gas Pipe Line Company, LLC. Any reuse of this report, particular by third parties, without expressing the permission of AECOM is solely at their own risk.

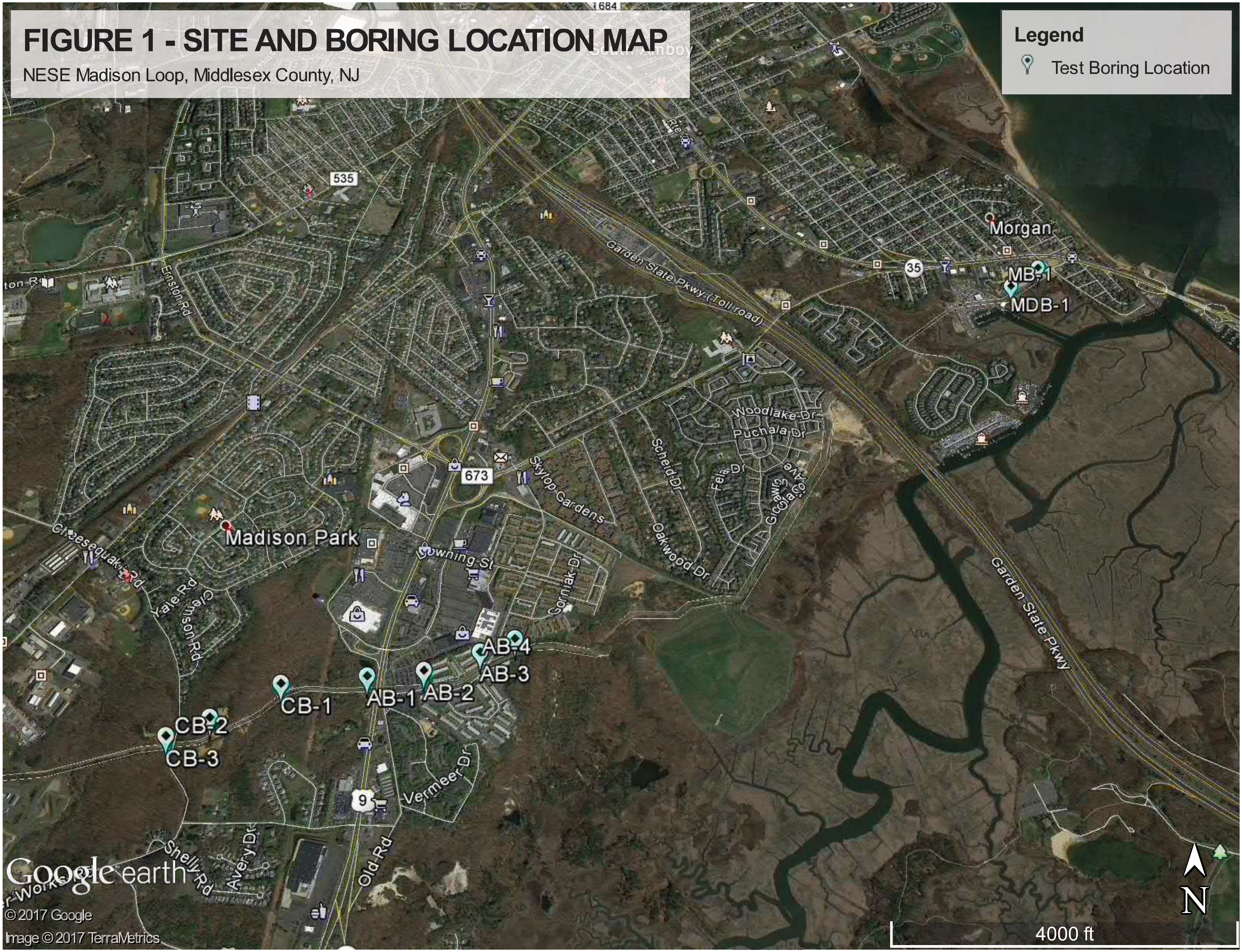
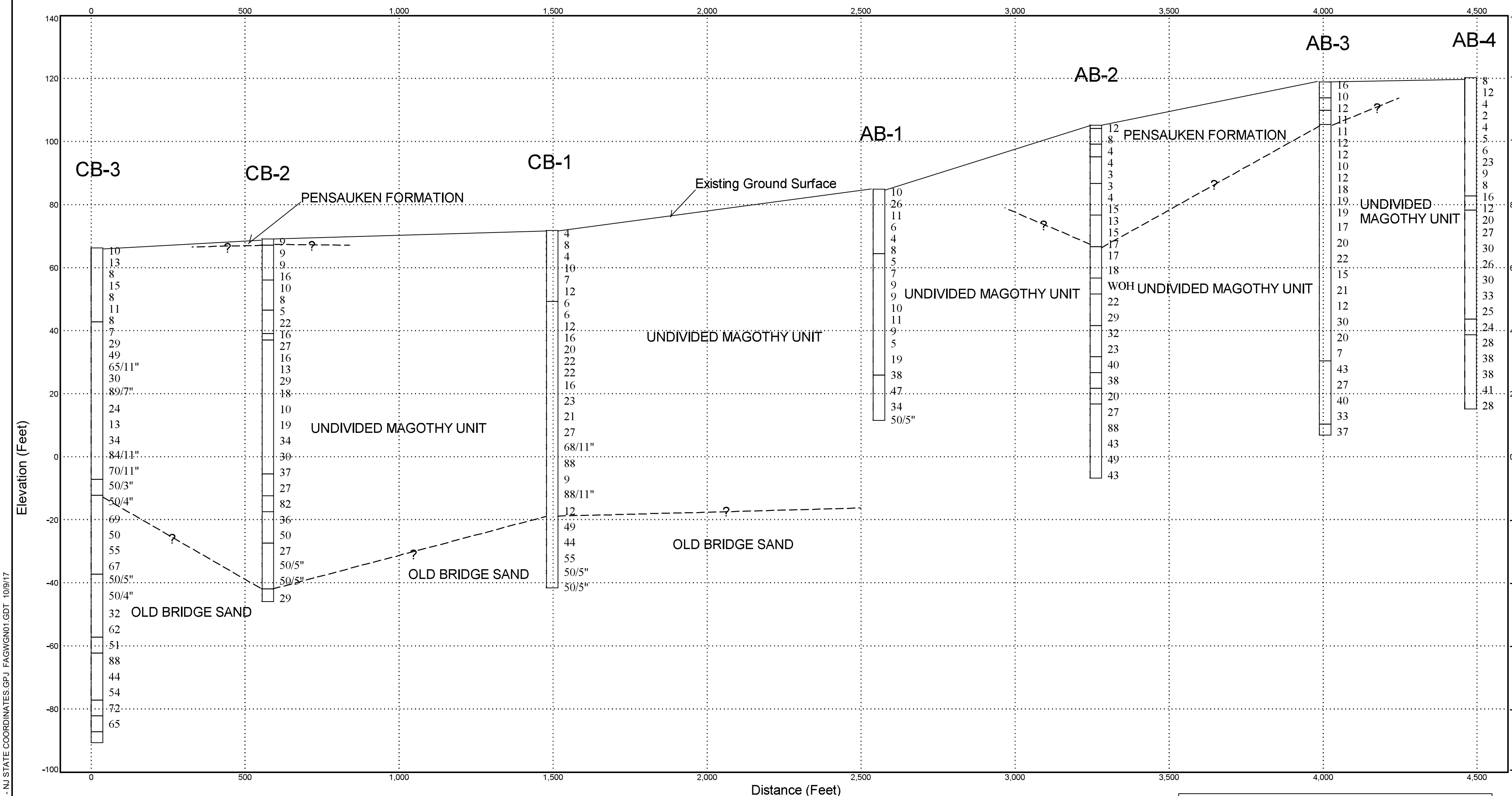


FIGURE 1 - SITE AND BORING LOCATION MAP
NESE Madison Loop, Middlesex County, NJ
Legend
Test Boring Location
Morgan
MB-1
MDB-1
35
535
673
9
Garden State Pkwy (Toll road)
Garden State Pkwy
Ernston Rd
Woodlake Dr
Puchala Dr
Fela Dr
Scheid Dr
Oakwood Dr
Skylop Gardens
Gorniak Dr
Downing St
Madison Park
Cheesequake Rd
Yale Rd
Clemson Rd
Vermeer Dr
Old Rd
Avery Dr
Shelly Rd
AB-1
AB-2
AB-3
AB-4
CB-1
CB-2
CB-3
N
4000 ft
Google earth
© 2017 Google
Image © 2017 TerraMetrics


FIGURE 2 - BORING LOCATION PLAN (1 of 2)
NESE Madison Loop, Middlesex County, NJ
Legend
Test Boring Location
673
Madison Park
Columbia Rd
Fordham Rd
Purdue Rd
Yale Rd
Clemson Rd
Brandeis Rd
Skytop Gardens
Wells Dr
N Mall Dr
S Mall Dr
Meiela Way
AB-1
AB-2
AB-3
AB-4
CB-1
CB-2
CB-3
Cheesequake Rd
Parkwood Dr
Van Delft Dr
Vermeer Dr
Brewster Cir
Poor Farm Rd
Avery Dr
Shelly Rd
Old Rd
9
N
2000 ft
Google earth
© 2017 Google

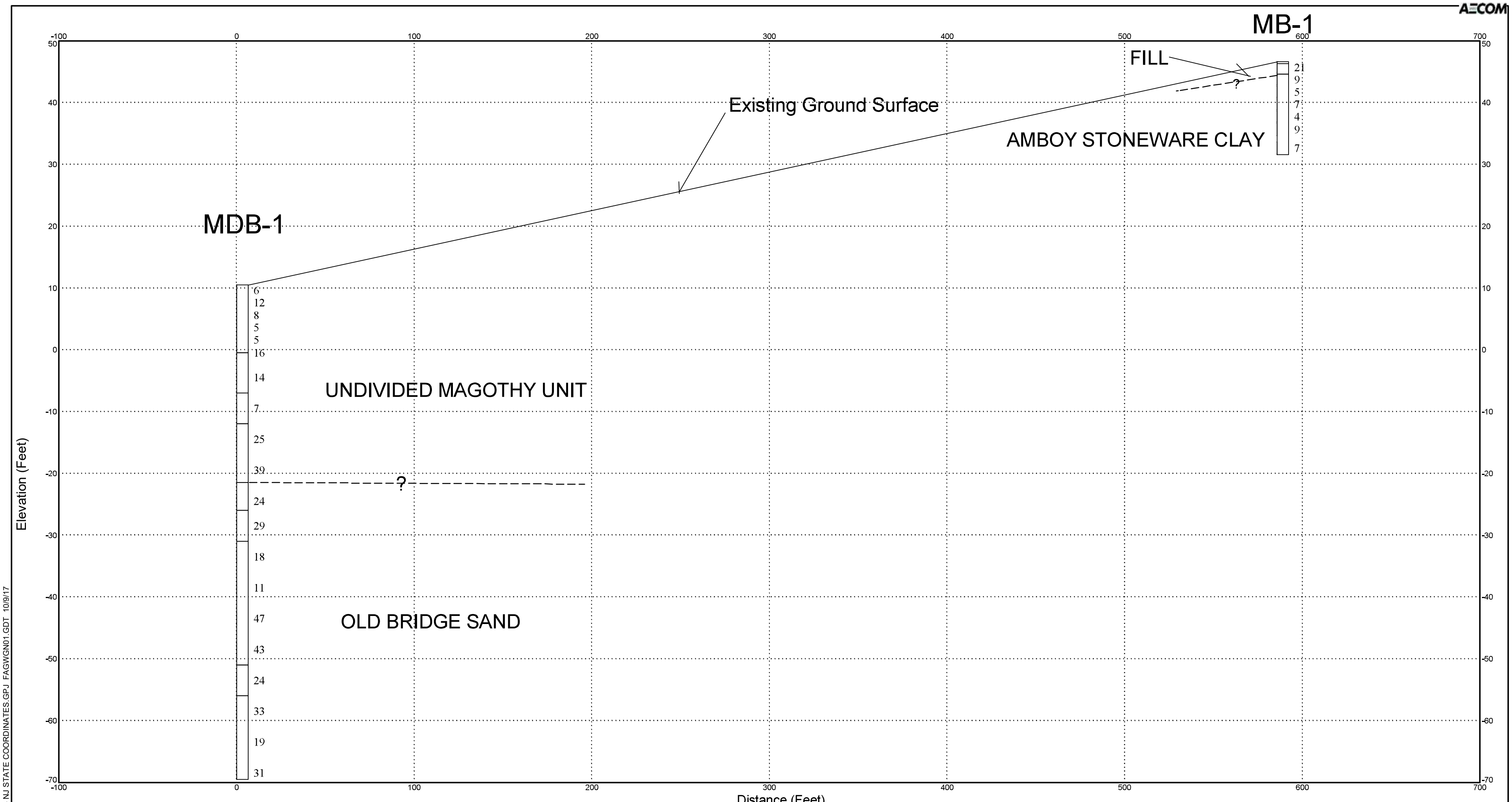

FIGURE 2 - BORING LOCATION PLAN (2 of 2)
NESE Madison Loop, Middlesex County, NJ
Legend
Test Boring Location
Morgan
Bay St
Dodd Pl
South St
Tyler St
Midland Ave
Vineyard Ave
Stevens Ave
Raritan Ave
Terrace
Mason Ave
Dolan Ave
Ziegle Ln
1st St
2nd St
Morgan Ave
Cliff Ave
Applegate Pl
MB-1
MDB-1
N
800 ft
Google earth
© 2017 Google

AECOM



INFERRED SUBSURFACE PROFILE
Northeast Supply Enhancement - Madison Loop
Middlesex County, New Jersey

PROJECT #	DATE	FIGURE
60515039	Oct-09-17	3-1



INFERRED SUBSURFACE PROFILE Northeast Supply Enhancement - Madison Loop Middlesex County, New Jersey		
PROJECT # 60515039	DATE Oct-09-17	FIGURE 3-2

WILLIAMS NESE NESE MADISON - NJ STATE COORDINATES.GPJ FAGWGN01.GDT 10/9/17

TABLE 1
Summary of Test Borings
Northeast Supply Enhancement - Madison Loop
Middlesex County, New Jersey

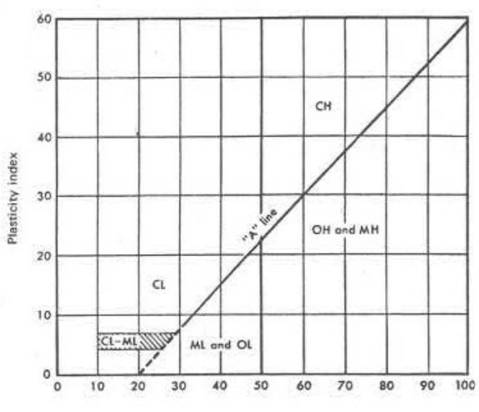
Boring ID	Northing	Easting	Termination Depth (ft, bgs)	Ground Surface Elevation (ft)	Estimated Groundwater Depth (ft, bgs)	Estimated Groundwater Elevation (ft)
AB-1	40.4450390	-74.3002870	73.4	84.9	4.5	80.4
AB-2	40.4452552	-74.2977352	112.0	105.2	45.0	60.2
AB-3	40.4459630	-74.2952180	112.0	118.9	55.0	63.9
AB-4	40.4464840	-74.2936500	105.0	120.2	9.6	110.6
CB-1	40.4447580	-74.3041550	113.4	71.8	See Note 1	See Note 1
CB-2	40.4434910	-74.3071260	115.0	69.1	12.9	56.2
CB-3	40.4428202	-74.3089444	157.0	66.3	44.0	22.3
MB-1	40.4635540	-74.2661460	15.0	46.6	NE	NA
MDB-1	40.4625600	-74.2678010	80.0	10.5	7.5	3.0

Notes:
BGS = below ground surface
NE = not encountered
NA = not available
1 = Groundwater level could not be measured due to the drilling method, although groundwater was not encountered until the depth of 31 feet during the drilling (i.e., groundwater level is deeper than 31 feet BGS).

Appendix A

Test Boring Logs

Major Divisions			Group symbols		Typical names	Laboratory classification criteria	
Coarse-grained soils (More than half of material is larger than No. 200 sieve size)	Gravels (More than half of coarse fraction is larger than No. 4 sieve size)	Clean gravels (Little or no fines)	GW		Well-graded gravels, gravel-sand mixture, little or no fines	Determine percentages of sand and gravel from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows: Less than 5 per cent ... GW, GP, SW, SP; More than 12 per cent ... GM, GC, SM, SC; 5 to 12 per cent ... *Borderline* cases requiring dual symbols**	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3
			GP		Poorly graded gravels, gravel-sand mixtures, little or no fines		Not meeting all gradation requirements for GW
		Gravels with fines (Appreciable amount of fines)	GM*	d / u	Silty gravels, gravel-sand-silt mixtures		Atterberg limits below "A" line or P.I. less than 4 — Above "A" line with P.I. between 4 and 7 are *borderline* cases requiring use of dual symbols
			GC		Clayey gravels, gravel-sand-clay mixtures		Atterberg limits above "A" line with P.I. greater than 7
	Sands (More than half of coarse fraction is smaller than No. 4 sieve size)	Clean sands (Little or no fines)	SW		Well-graded sands, gravelly sands, little or no fines		$C_u = \frac{D_{60}}{D_{10}}$ greater than 6; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3
			SP		Poorly graded sands, gravelly sands, little or no fines		Not meeting all gradation requirements for SW
		Sands with fines (Appreciable amount of fines)	SM*	d / u	Silty sands, sand-silt mixtures		Atterberg limits below "A" line or P.I. less than 4 — Limits plotting in hatched zone with P.I. between 4 and 7 are *borderline* cases requiring use of dual symbols.
			SC		Clayey sands, sand-clay mixtures		Atterberg limits above "A" line with P.I. > than 7
Fine-grained soils (More than half of material is smaller than No. 200 sieve)	Silts and clays (Liquid limit less than 50)		ML		Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity		
			CL		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays		
			OL		Organic silts and organic silty clays of low plasticity		
	Silts and clays (Liquid limit greater than 50)		MH		Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts		
			CH		Inorganic clays of high plasticity, fat clays		
			OH		Organic clays of medium to high plasticity, organic silts		
Highly organic soils			Pt		Peat and other highly organic soils		



Plasticity Chart

Particle Size		
Material	Sieve Size	mm
Silt or Clay	<#200	<0.074
Sand Fine	#200 To #40	0.074 To 0.42
Sand Med.	# 40 To #10	0.42 To 2.00
Sand Coarse	# 10 To # 4	2.00 To 4.76

Particle Size		
Material	Sieve	mm
Gravel Fine	#4 To 3/4 In.	4.76 To 19.1
Gravel Coarse	3/4 In To 3 In.	19.1 To 76.2
Cobbles	3 In. To 12 In.	76.2 To 304.8
Boulders	12 In. To 36 In.	304.8 To 914.4

*Division of GM and SM groups into subdivisions of d and u are for roads and airfields only. Subdivision is based on Atterberg limits; suffix d used when L.L. is 28 or less and the P.I. is 6 or less; the suffix u used when L.L. is greater than 28.

**Borderline classifications, used for soils possessing characteristics of two groups, are designated by combinations of group symbols. For example: GW-GC, well-graded gravel-sand mixture with clay binder.

KEY TO SOIL SYMBOLS AND TERMS

Terms used in this report for describing soils according to their texture or grain size distribution are in accordance with the Unified Soil Classification System, as described in Technical Memorandum No. 3-357, Waterways Experiment Station, March 1953.

TERMS DESCRIBING CONSISTENCY OR CONDITION

COARSE GRAINED SOILS (major portion retained on No. 200 sieve): Includes (1) clean gravels and (2) silty or clayey gravels and sands. Condition is rated according to relative density(1) as determined by laboratory tests or standard penetration resistance tests.

Descriptive Term	Relative Density
Very loose	0 to 15%
Loose	15 to 35%
Medium dense	35 to 65%
Dense	65 to 85%
Very dense	85 to 100%

FINE GRAINED SOILS (major portion passing No. 200 sieve): Includes (1) inorganic and organic silts and clays, (2) gravelly, sandy, or silty clays, and (3) clayey silts. Consistency is rated according to shearing strength, as indicated by penetrometer readings or by unconfined compression tests.

Descriptive Term	Unconfined Compression Strength, tons/sq. ft.
Very soft	less than 0.25
Soft	0.25 to 0.50
Firm	0.50 to 1.00
Stiff	1.00 to 2.00
Very stiff	2.00 to 4.00
Hard	4.00 and higher

TEST AND SAMPLE IDENTIFICATION

- 15 – The number of blows (15) of a 140-pound hammer falling 30 inches used to drive a 2" O. D. split-barrel sampler for the last 12 inches of penetration.
- 50/2 – Number of blows (50) used to drive the split-barrel a certain number of inches (2).
- P – Thin-wall tube sample.
- P250 – Thin-wall tube pushed hydraulically, using a certain pressure (250 psi) to push the last 6 inches.
- C_t – Denison or Pitcher-Type – core-barrel sample.
- Ps – Piston sample.
- A – Augar sample.
- BX – Rock cored with BX core barrel, which obtains a 1-5/8" diameter core.
- NX – Rock cored with NX core barrel, which obtains a 2-1/8" diameter core.
- 65% – Percentage (65) of rock core recovered.
- 20% – Rock Quality Designation (RQD)(2)
- VS – Vane Shear Test.

Sample Recovered / Sample Not Recovered

Laboratory Test Performed:

- C – Consolidation and specific gravity tests.
- D – Maximum & minimum density.
- DS – Direct Shear test.
- G – Specific gravity test.
- K – Permeability test.
- M – Mechanical (sieve or hydrometer) analysis.
- T – Triaxial compression test
- U – Unconfined compression test.
- W – Unit weight & natural moisture content.
- X – Special tests performed – see Laboratory test results.

(2)RQD = $\frac{\sum \text{Core Segments} \geq 4 \text{ Inches}}{\text{Core Interval}} \times 100$

Where Segmentation Is Not Caused By Drilling Effects

(1)ASTM 2049-69

LOG of BORING No. AB-1

DATE 8/14/2017 SURFACE ELEVATION 84.9 LOCATION Northing: 40.445039 Easting: -74.300287

DEPTH, FT.	SAMPLES	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
0										
		10	SS	Loose to very dense brown to orange brown silty coarse to fine SAND, trace gravel						
		26	SS							
5		11	SS							
		6	SS							
		4	SS				11.7			M
10										
		8	SS							
15		5	SS							
20		7	SS		64.4	1.5				
				Stiff to very stiff dark gray silty CLAY, trace sand						
25		9	SS			1.6	28.4			M
30		9	SS			2.5				
		10	SS			1.9				
35										
		11	SS			2.3				
40										
				(Undivided Magothy Unit)						
		9	SS			2.4				

(Continued on Sheet 2 of 2)

Completion Depth: 73.4 ft. Water Depth: See Notes ft., After ___ hrs.

Project No.: 60515039 ___ ft., After ___ hrs.

Project Name: Williams NESE Madison ___ ft., After ___ hrs.

Drilling Method: Hollow Stem Auger + Mud Rotary ___ ft., After ___ hrs.

AECOM

LOG of BORING No. AB-1

Sheet 2 of 2

DATE 8/14/2017 SURFACE ELEVATION 84.9 LOCATION Northing: 40.445039 Easting: -74.300287

DEPTH, FT.	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
45			- Continuing stiff to very stiff dark gray silty to sandy CLAY						
50	5	SS			1.4	27.5	38	23	
55	19	SS			2.9				
60	38	SS		25.9	2.0	18.7			M
			Dense to very dense gray to dark gray sandy SILT to silty medium to fine SAND, trace gravel						
65	47	SS							
70	34	SS							
	50/5"	SS	(Undivided Magothy Unit)	11.5					
75									
80									
85									

Notes:
1. Ground surface elevation at the boring location was surveyed by Williams surveyors.
2. Groundwater level was measured at approximately 4.5 ft below existing ground surface on completion of drilling.
3. Values under "Pocket Penetrometer" are pocket penetrometer resistance readings in tons per square foot, an indication of unconfined compressive strength of cohesive soils.

Completion Depth: 73.4 ft. Water Depth: See Notes ft., After ____ hrs.

Project No.: 60515039

Project Name: Williams NESE Madison

Drilling Method: Hollow Stem Auger + Mud Rotary

AECOM

LOG of BORING No. AB-2

DATE 9/21/2016-9/22/2016 SURFACE ELEVATION 105.2 LOCATION Northing: 40.44525521 Easting: -74.29773516

DEPTH, FT.	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
0	12	SS	TOPSOIL	104.2					
	8	SS	Loose to dense orange brown to brown silty medium to fine SAND with gravel						
5	4	SS		99.2					
	4	SS	Loose orange brown gravelly medium to fine SAND with silt						
	3	SS		95.2					
10	3	SS	Loose orange brown silty medium to fine SAND with gravel						
15	4	SS		86.7					
20	15	SS	Medium dense light brown to reddish brown medium to fine SAND						
25	13	SS		76.7					
30	15	SS	Medium dense orange brown coarse to fine SAND with gravel, trace silt						
35	17	SS	(Pennsauken Formation)	66.7					
40	17	SS	Medium dense orange brown to light gray medium to fine SAND (Undivided Magothy Unit)						

(Continued on Sheet 2 of 3)

Completion Depth: 112.0 ft.
Project No.: 60515039
Project Name: Williams NESE Madison
Drilling Method: Hollow Stem Auger

Water Depth: See Notes ft., After ____ hrs.
____ ft., After ____ hrs.
____ ft., After ____ hrs.
____ ft., After ____ hrs.

AECOM

LOG of BORING No. AB-2

DATE 9/21/2016-9/22/2016 SURFACE ELEVATION 105.2 LOCATION Northing: 40.44525521 Easting: -74.29773516

DEPTH, FT.	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
45	18	SS	- Continuing medium dense orange brown to light gray medium to fine SAND	56.7					
50	WOH	SS	Very loose orange brown to brown silty coarse to fine SAND, some gravel	51.7		23.9			M
55	22	SS	Very stiff gray to dark gray SILT with sand			26.8	42	26	M
60	29	SS		41.7	2.7	22.6			M
65	32	SS	Medium dense to dense light gray to dark gray silty medium to fine SAND						
70	23	SS		31.7		24.4			M
75	40	SS	Very dense gray sandy SILT	26.7		21.4			M
80	38	SS	Hard gray CLAY with sand	21.7		26.0	35	22	M
85	20	SS	Very stiff gray SILT with sand (Undivided Magothy Unit)	16.7		24.4			M

(Continued on Sheet 3 of 3)

Completion Depth: 112.0 ft. Water Depth: See Notes ft., After ___ hrs.

Project No.: 60515039

Project Name: Williams NESE Madison

Drilling Method: Hollow Stem Auger

AECOM

LOG of BORING No. AB-2

DATE 9/21/2016-9/22/2016 SURFACE ELEVATION 105.2 LOCATION Northing: 40.44525521 Easting: -74.29773516

DEPTH, FT.	SAMPLES	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
90		27	SS	Medium dense to very dense light gray to dark gray silty coarse to fine SAND						
95		88	SS				22.0			M
100		43	SS							
105		49	SS							
110		43	SS	(Undivided Magothy Unit)	-6.8					
115										
120										
125										
130										

Notes:
1. Ground surface elevation at the boring location was surveyed by Williams surveyors.
2. Groundwater levels were measured as shown below:

Date & Time	GW Depth (ft)	GW Elev. (ft)
09/21/16 10:30	45.0	60.2

3. Values under "Pocket Penetrometer" are pocket penetrometer resistance readings in tons per square foot, an indication of unconfined compressive strength of cohesive soils.

Completion Depth: 112.0 ft.
Project No.: 60515039
Project Name: Williams NESE Madison
Drilling Method: Hollow Stem Auger

Water Depth: See Notes ft., After ___ hrs.
___ ft., After ___ hrs.
___ ft., After ___ hrs.
___ ft., After ___ hrs.

AECOM

LOG of BORING No. AB-3

DATE 9/22/2016-9/23/2016 SURFACE ELEVATION 118.9 LOCATION Northing: 40.44596302 Easting: -74.29521804

DEPTH, FT.	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
0	16	SS	Dense to very dense brownish gray to orange brown sandy to clayey SILT						
	10	SS							
5	12	SS		113.9					
			Medium dense light to reddish brown silty coarse to fine SAND with gravel						
	11	SS				18.8			M
			(Pennsauken Formation)						
	11	SS		109.9					
10	12	SS	Very stiff gray to orange brown sandy CLAY		2.7	17.4	34	18	M
				105.4					
15	12	SS	Medium dense light gray to orange brown silty medium to fine SAND						
20	10	SS				12.5			M
25	12	SS							
30	18	SS				8.6			M
35	19	SS							
40	19	SS				12.5			M
			(Undivided Magothy Unit)						

(Continued on Sheet 2 of 3)

Completion Depth: 112.0 ft. Water Depth: See Notes ft., After ___ hrs.

Project No.: 60515039 ft., After ___ hrs.

Project Name: Williams NESE Madison ft., After ___ hrs.

Drilling Method: Hollow Stem Auger ft., After ___ hrs.

AECOM

LOG of BORING No. AB-3

DATE 9/22/2016-9/23/2016 SURFACE ELEVATION 118.9 LOCATION Northing: 40.44596302 Easting: -74.29521804

DEPTH, FT.	SAMPLES	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
45		17	SS	- Continuing medium dense light gray to orange brown silty medium to fine SAND						
50		20	SS				12.2			M
55		22	SS							
60		15	SS				8.7			M
65		21	SS							
70		12	SS				23.8			M
75		30	SS				12.1			M
80		20	SS				12.0			M
85		7	SS	(Undivided Magothy Unit)	30.4					

(Continued on Sheet 3 of 3)

Completion Depth: 112.0 ft.

Project No.: 60515039

Project Name: Williams NESE Madison

Drilling Method: Hollow Stem Auger

Water Depth: See Notes ft., After ___ hrs.

LOG of BORING No. AB-3

DATE 9/22/2016-9/23/2016 SURFACE ELEVATION 118.9 LOCATION Northing: 40.44596302 Easting: -74.29521804

DEPTH, FT.	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
90	43	SS	Medium dense to dense dark gray to black SILT to sandy SILT			30.3	45	29	M
95	27	SS				37.9			M
100	40	SS							
105	33	SS							
				10.4					
			Medium dense gray silty fine SAND						
110	37	SS	(Undivided Magothy Unit)	6.9					
115									
120									
125									
130									

Notes:
1. Ground surface elevation at the boring location was surveyed by Williams surveyors.
2. Groundwater levels were measured as shown below:

Date & Time	GW Depth (ft)	GW Elev. (ft)
09/22/16 13:20	71.0	47.9
09/23/16 09:45	55.0	63.9

3. Values under "Pocket Penetrometer" are pocket penetrometer resistance readings in tons per square foot, an indication of unconfined compressive strength of cohesive soils.

Completion Depth: 112.0 ft.
Project No.: 60515039
Project Name: Williams NESE Madison
Drilling Method: Hollow Stem Auger

Water Depth: See Notes ft., After ____ hrs.
____ ft., After ____ hrs.
____ ft., After ____ hrs.
____ ft., After ____ hrs.

AECOM

LOG of BORING No. AB-4

DATE 8/21/2017 SURFACE ELEVATION 120.2 LOCATION Northing: 40.446484 Easting: -74.29365

DEPTH, FT.	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
0	8	SS	Loose to dense light gray to orange brown silty medium to fine SAND to medium to fine SAND with silt						
	12	SS							
5	4	SS							
	2	SS							
	4	SS				12.8			M
10	5	SS							
15	6	SS							
20	23	SS							
25	9	SS							
30	8	SS				12.0			M
35	16	SS							
				82.7					
40	12	SS	Firm to stiff light brown to orange brown sandy silty CLAY		0.8	22.6	30	18	
				78.2					
			(Undivided Magothy Unit)						
	20	SS	(Continued on Sheet 2 of 3)						

Completion Depth: 105.0 ft. Water Depth: See Notes ft., After ____ hrs.

Project No.: 60515039 ft., After ____ hrs.

Project Name: Williams NESE Madison ft., After ____ hrs.

Drilling Method: Hollow Stem Auger + Mud Rotary ft., After ____ hrs.

AECOM

LOG of BORING No. AB-4

DATE 8/21/2017 SURFACE ELEVATION 120.2 LOCATION Northing: 40.446484 Easting: -74.29365

DEPTH, FT.	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
45			Medium dense to dense orange brown to dark brown silty medium to fine SAND with clay						
50	27	SS							
55	30	SS							
60	26	SS							
65	30	SS							
70	33	SS							
75	25	SS		43.7					
			Stiff to very stiff gray to brown silty sandy CLAY						
80	24	SS		38.7	1.9	28.0	43	22	
			Medium dense to dense grayish brown to orange brown silty medium to fine SAND						
85	28	SS				17.5			M
			(Undivided Magothy Unit)						
	38	SS							

(Continued on Sheet 3 of 3)

Completion Depth: 105.0 ft.
Project No.: 60515039
Project Name: Williams NESE Madison
Drilling Method: Hollow Stem Auger + Mud Rotary

Water Depth: See Notes ft., After ___ hrs.

LOG of BORING No. AB-4

DATE 8/21/2017 SURFACE ELEVATION 120.2 LOCATION Northing: 40.446484 Easting: -74.29365

DEPTH, FT.	SAMPLES	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
90				- Continuing medium dense to dense brown to orange brown silty medium to fine SAND						
95	■	38	SS							
100	■	41	SS							
105	■	28	SS	(Undivided Magothy Unit)	15.2					
110				Notes: 1. Ground surface elevation at the boring location was surveyed by Williams surveyors. 2. Groundwater level was measured at approximately 9.6 ft below existing ground surface on completion of drilling. 3. Values under "Pocket Penetrometer" are pocket penetrometer resistance readings in tons per square foot, an indication of unconfined compressive strength of cohesive soils.						
115										
120										
125										
130										

Completion Depth: 105.0 ft. Water Depth: See Notes ft., After ____ hrs.

Project No.: 60515039 ____ ft., After ____ hrs.

Project Name: Williams NESE Madison ____ ft., After ____ hrs.

Drilling Method: Hollow Stem Auger + Mud Rotary ____ ft., After ____ hrs.

LOG of BORING No. CB-1

DATE 8/14/2017-8/15/2017 SURFACE ELEVATION 71.8 LOCATION Northing: 40.444758 Easting: -74.304155

DEPTH, FT.	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
0	4	SS	Firm to very stiff dark gray to gray silty to sandy CLAY		1.8				
	8	SS			2.4				
5	4	SS			1.6				
	10	SS			1.9				
	7	SS			1.6				
10	12	SS			1.0				
15	6	SS			1.5				
20	6	SS			1.6				
				49.3					
25	12	SS	Medium dense gray to orange brown silty fine SAND to sandy SILT						
30	16	SS							
35	20	SS							
40	22	SS							
	22	SS	(Undivided Magothy Unit)						

(Continued on Sheet 2 of 3)

Completion Depth: 113.4 ft.
Project No.: 60515039
Project Name: Williams NESE Madison
Drilling Method: Hollow Stem Auger + Mud Rotary

Water Depth: See Notes ft., After ___ hrs.

AECOM

LOG of BORING No. CB-1

DATE 8/14/2017-8/15/2017 SURFACE ELEVATION 71.8 LOCATION Northing: 40.444758 Easting: -74.304155

DEPTH, FT.	SAMPLES	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
45				- Continuing medium dense to very dense gray to orange brown silty medium to fine SAND						
50		16	SS							
55		23	SS							
60		21	SS							
65		27	SS							
70		68/11"	SS							
75		88	SS							
80		9	SS	- loose						
85		88/11"	SS							
		12	SS	(Undivided Magothy Unit)						

(Continued on Sheet 3 of 3)

Completion Depth: 113.4 ft.
Project No.: 60515039
Project Name: Williams NESE Madison
Drilling Method: Hollow Stem Auger + Mud Rotary

Water Depth: See Notes ft., After ___ hrs.
___ ft., After ___ hrs.
___ ft., After ___ hrs.
___ ft., After ___ hrs.

AECOM

LOG of BORING No. CB-1

Sheet 3 of 3

DATE 8/14/2017-8/15/2017 SURFACE ELEVATION 71.8 LOCATION Northing: 40.444758 Easting: -74.304155

DEPTH, FT.	SAMPLES	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
90				- Continuing very dense light gray to orange brown silty fine SAND to sandy SILT						
95		49	SS							
100		44	SS							
105		55	SS							
110		50/5"	SS							
		50/5"	SS	(Old Bridge Sand)	-41.6					
115										
120										
125										
130										

Notes:
1. Ground surface elevation at the boring location was surveyed by Williams surveyors.
2. Groundwater level could not be measured due to the drilling method.
3. Values under "Pocket Penetrometer" are pocket penetrometer resistance readings in tons per square foot, an indication of unconfined compressive strength of cohesive soils.

Completion Depth: 113.4 ft.
Project No.: 60515039
Project Name: Williams NESE Madison
Drilling Method: Hollow Stem Auger + Mud Rotary

Water Depth: See Notes ft., After ___ hrs.
___ ft., After ___ hrs.
___ ft., After ___ hrs.

AECOM

LOG of BORING No. CB-2

DATE 8/23/2017 SURFACE ELEVATION 69.1 LOCATION Northing: 40.443491 Easting: -74.307126

DEPTH, FT.	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
0	9	SS	Medium dense orange brown silty coarse to fine SAND with gravel						
			(Pennsauken Formation)	67.1					
	9	SS							
5	9	SS	Medium dense to dense light brown to orange brown medium to fine SAND with silt			5.6			M
	16	SS							
	10	SS							
10	8	SS							
				56.1					
15	5	SS	Soft to very stiff brownish gray to dark gray clayey SILT to silty CLAY, trace sand		0.3	25.3			M
20	22	SS			4.1				
				46.6					
25	16	SS	Medium dense gray to brown silty fine SAND			22.6			M
				39.1					
30	27	SS	Very stiff to hard dark gray silty CLAY		>4.5	21.2			M
				37.1					
35	16	SS	Medium dense to dense light brown silty medium to fine SAND to medium to fine SAND with silt						
40	13	SS							
	29	SS	(Undivided Magothy Unit)						

(Continued on Sheet 2 of 3)

Completion Depth: 115.0 ft. Water Depth: See Notes ft., After ___ hrs.

Project No.: 60515039

Project Name: Williams NESE Madison

Drilling Method: Hollow Stem Auger + Mud Rotary

AECOM

LOG of BORING No. CB-2

Sheet 2 of 3

DATE 8/23/2017 SURFACE ELEVATION 69.1 LOCATION Northing: 40.443491 Easting: -74.307126

DEPTH, FT.	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
45			- Continuing medium dense to dense orange brown to light grayish brown silty medium to fine SAND to medium to fine SAND with silt						
50	18	SS							
55	10	SS							
60	19	SS							
65	34	SS							
70	30	SS	- trace gravel			22.4			M
75	37	SS		-5.4	>4.5				
			Very stiff brownish gray to light brown silty to sandy CLAY						
80	27	SS			2.1	20.0			M
				-12.4					
			Very dense gray silty medium to fine SAND, trace clay						
85	82	SS							
				-17.4					
			(Undivided Magothy Unit)						
	36	SS	(Continued on Sheet 3 of 3)						

Completion Depth: 115.0 ft. Water Depth: See Notes ft., After ___ hrs.

Project No.: 60515039

Project Name: Williams NESE Madison

Drilling Method: Hollow Stem Auger + Mud Rotary

10/13/17 WILLIAMS NESE MADISON.GPJ

LOG of BORING No. CB-2

Sheet 3 of 3

DATE 8/23/2017 SURFACE ELEVATION 69.1 LOCATION Northing: 40.443491 Easting: -74.307126

DEPTH, FT.	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
90			Medium dense to dense gray to dark brownish gray sandy to clayey SILT						
	50	SS			3.6	28.5			M
95			(Undivided Magothy Unit)	-27.4					
	27	SS	Medium dense to very dense gray to brownish gray silty medium to fine SAND, trace gravel						
100									
	50/5"	SS							
105									
	50/5"	SS							
110				-41.9					
			Stiff to very stiff light brown silty CLAY						
	29	SS	(Old Bridge Sand)	-45.9	1.8				
115									
120									
125									
130									

Notes:
1. Ground surface elevation at the boring location was surveyed by Williams surveyors.
2. Groundwater level was measured at approximately 12.9 ft below existing ground surface on completion of drilling.
3. Values under "Pocket Penetrometer" are pocket penetrometer resistance readings in tons per square foot, an indication of unconfined compressive strength of cohesive soils.

Completion Depth: 115.0 ft. Water Depth: See Notes ft., After ___ hrs.

Project No.: 60515039 ___ ft., After ___ hrs.

Project Name: Williams NESE Madison ___ ft., After ___ hrs.

Drilling Method: Hollow Stem Auger + Mud Rotary ___ ft., After ___ hrs.

10/13/17 WILLIAMS NESE MADISON.GPJ

AECOM

LOG of BORING No. CB-3

Sheet 1 of 4

DATE 9/15/2016-9/20/2016 SURFACE ELEVATION 66.3 LOCATION Northing: 40.44282019 Easting: -74.30894441

DEPTH, FT.	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
0	10	SS	Loose to medium dense orange brown to light brown silty coarse to fine SAND, trace gravel						
	13	SS							
5	8	SS				16.5			M
	15	SS							
	8	SS							
10	11	SS							
15	8	SS							
20	7	SS				16.7			M
				42.8					
25	29	SS	Medium dense to very dense orange brown to light brown SILT with sand to silty medium to fine SAND						
30	49	SS				5.0			M
35	65/11"	SS				3.7			M
40	30	SS							
			(Undivided Magothy Unit)						

(Continued on Sheet 2 of 4)

Completion Depth: 157.0 ft.

Project No.: 60515039

Project Name: Williams NESE Madison

Drilling Method: Hollow Stem Auger

Water Depth: See Notes ft., After ___ hrs.

AECOM

LOG of BORING No. CB-3

DATE 9/15/2016-9/20/2016 SURFACE ELEVATION 66.3 LOCATION Northing: 40.44282019 Easting: -74.30894441

DEPTH, FT.	SAMPLES	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
45		89/7"	SS	- Continuing medium dense to very dense orange brown to light brown SILT with sand to silty medium to fine SAND			20.2			M
50		24	SS							
55		13	SS	- trace gravel			19.1			M
60		34	SS							
65		84/11"	SS				23.0			M
70		70/11"	.ss.							
					-7.2					
75		50/3"	SS	Very stiff to hard light gray to orange brown CLAY with sand (Undivided Magothy Unit)		3.3	16.7	29	17	M
					-12.2					
80		50/4"	SS	Very dense light brown to light gray silty medium to fine SAND			22.4			M
85		69	SS	(Old Bridge Sand)						

(Continued on Sheet 3 of 4)

Completion Depth: 157.0 ft. Water Depth: See Notes ft., After ____ hrs.

Project No.: 60515039

Project Name: Williams NESE Madison

Drilling Method: Hollow Stem Auger

LOG of BORING No. CB-3

DATE 9/15/2016-9/20/2016 SURFACE ELEVATION 66.3 LOCATION Northing: 40.44282019 Easting: -74.30894441

DEPTH, FT.	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
90	50	SS	- Continuing very dense light brown to light gray silty medium to fine SAND			21.0			M
95	55	SS				22.8			M
100	67	SS		-37.2					
105	50/5"	SS	Medium dense to very dense light brown to orange brown medium to fine SAND with silt						
110	50/4"	SS				22.7			M
115	32	SS							
120	62	SS		-57.2					
125	51	SS	Dense light gray sandy SILT with clay	-62.2					
130	88	SS	Dense to very dense light gray to orange brown coarse to fine SAND (Old Bridge Sand)						

(Continued on Sheet 4 of 4)

Completion Depth: 157.0 ft.
Project No.: 60515039
Project Name: Williams NESE Madison
Drilling Method: Hollow Stem Auger

Water Depth: See Notes ft., After ____ hrs.

LOG of BORING No. CB-3

DATE 9/15/2016-9/20/2016 SURFACE ELEVATION 66.3 LOCATION Northing: 40.44282019 Easting: -74.30894441

DEPTH, FT.	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
135	44	SS	- Continuing dense to very dense light gray to orange brown coarse to fine SAND						
140	54	SS							
				-77.2					
145	72	SS	Very stiff to hard light gray silty CLAY		3.2				
				-82.2					
150	65	SS	Dense to very dense dark gray to light brown silty fine SAND, trace clay						
				-87.2					
155			- no sample taken at 155 to 157 ft (Old Bridge Sand)	-90.7					
160									
165									
170									
175									

Notes:
1. Ground surface elevation at the boring location was surveyed by Williams surveyors.
2. Groundwater levels were measured as shown below:

Date & Time	GW Depth (ft)	GW Elev. (ft)
09/16/16 08:55	42.0	24.3
09/16/16 10:55	40.7	25.6
09/20/16 08:00	44.0	22.3

3. Values under "Pocket Penetrometer" are pocket penetrometer resistance readings in tons per square foot, an indication of unconfined compressive strength of cohesive soils.

Completion Depth: 157.0 ft. Water Depth: See Notes ft., After ___ hrs.
Project No.: 60515039
Project Name: Williams NESE Madison
Drilling Method: Hollow Stem Auger

AECOM

LOG of BORING No. GB-1

DATE 9/26/2016-9/27/2016 SURFACE ELEVATION 40.0 LOCATION Northing: 40.45770783 Easting: -74.27776781

DEPTH, FT.	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
0	19	SS	TOPSOIL	39.7					
	10	SS	Very loose to medium dense light brown to orange brown silty medium to fine SAND						
5	4	SS				13.2			M
	4	SS							
	4	SS							
10	4	SS				17.1			M
15	6	SS	- trace gravel			17.3			M
20	6	SS				13.0			M
25	5	SS							
30	3	SS				21.1			M
35	12	SS							
				1.5					
40	10	SS	Stiff to hard gray CLAY, trace sand		>4.5	15.0	34	17	M
			(Undivided Magothy Unit)	-3.5					

(Continued on Sheet 2 of 3)

Completion Depth: 122.0 ft. Water Depth: See Notes ft., After ___ hrs.

Project No.: 60515039

Project Name: Williams NESE Madison

Drilling Method: Hollow Stem Auger

LOG of BORING No. GB-1

DATE 9/26/2016-9/27/2016 SURFACE ELEVATION 40.0 LOCATION Northing: 40.45770783 Easting: -74.27776781

DEPTH, FT.	SAMPLES	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
45		28	SS	Medium dense gray sandy SILT			18.1			M
					-8.5					
50		14	SS	Medium dense to very dense gray to orange brown silty medium to fine SAND			22.1			M
55		16	SS							
60		26	SS							
					-23.5					
65		17	SS	Very stiff gray to brown SILT, trace sand (Undivided Magothy Unit)			22.6			M
					-28.5					
70		95/11"	SS	Dense to very dense brown to orange brown medium to fine SAND with silt						
75		50/5"	SS							
80		75	SS				21.8			M
85		42	SS	(Old Bridge Sand)						

(Continued on Sheet 3 of 3)

Completion Depth: 122.0 ft.
Project No.: 60515039
Project Name: Williams NESE Madison
Drilling Method: Hollow Stem Auger

Water Depth: See Notes ft., After ____ hrs.
____ ft., After ____ hrs.
____ ft., After ____ hrs.
____ ft., After ____ hrs.

LOG of BORING No. GB-1

Sheet 3 of 3

DATE 9/26/2016-9/27/2016 SURFACE ELEVATION 40.0 LOCATION Northing: 40.45770783 Easting: -74.27776781

DEPTH, FT.	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
90	10	SS	- Continuing loose to very dense brown to orange brown medium to fine SAND with silt			21.3			M
95	20	SS							
100	27	SS							
105	34	SS				22.0			M
110	27	SS		-73.5					
115	37	SS	Hard gray and light brown silty CLAY with sand	-78.5	3.6				
120	50/5"	SS	Very dense orange brown and gray medium to fine SAND (Old Bridge Sand)	-82.0					

Notes:
1. Ground surface elevation at the boring location was surveyed by Williams surveyors.
2. Groundwater levels were measured as shown below:

Date & Time	GW Depth (ft)	GW Elev. (ft)
09/26/16 10:15	31.0	9.0
09/27/16 08:30	29.4	10.6

3. Values under "Pocket Penetrometer" are pocket penetrometer resistance readings in tons per square foot, an indication of unconfined compressive strength of cohesive soils.

Completion Depth: 122.0 ft.
Water Depth: See Notes ft., After ___ hrs.
Project No.: 60515039
Project Name: Williams NESE Madison
Drilling Method: Hollow Stem Auger

AECOM

LOG of BORING No. GB-2

DATE 8/24/2017 SURFACE ELEVATION 25.5 LOCATION Northing: 40.458656 Easting: -74.276231

DEPTH, FT.	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
0	4	SS	Medium dense light gray to orange brown fine SAND with silt						
	7	SS							
5	7	SS				9.8			
	9	SS							
	8	SS				8.3			M
10	7	SS							
15	8	SS				26.5			M
				8.0					
20	8	SS	Medium dense dark grayish brown to dark gray silty fine SAND			28.9	NP	NP	M
				0.5					
25	14	SS	Medium dense gray silty fine SAND						
				-2.0					
30	20	SS	Medium dense to dense grayish brown to brown silty coarse to fine SAND with gravel		0.5	16.4	NP	NP	M
				-6.5					
	52	SS	Very dense gray to orange brown fine SAND with silt			24.6			M
35									
				-11.0					
			Medium dense gray to dark gray sandy SILT						
				-13.5					
	22	SS	Very stiff gray to dark gray sandy silty CLAY		3.5				
40									
				-16.0					
			(Undivided Magothy Unit)						
	8	SS	(Continued on Sheet 2 of 3)						

Completion Depth: 80.0 ft. Water Depth: See Notes ft., After ___ hrs.

Project No.: 60515039

Project Name: Williams NESE Madison

Drilling Method: Hollow Stem Auger + Mud Rotary

AECOM

LOG of BORING No. GB-2

Sheet 2 of 3

DATE 8/24/2017 SURFACE ELEVATION 25.5 LOCATION Northing: 40.458656 Easting: -74.276231

DEPTH, FT.	SAMPLES	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
45				Medium dense to very dense gray to orange brown medium to fine SAND with silt						
		30	SS				24.4			M
50										
		25	SS							
55										
		27	SS							
60										
		38	SS							
65										
		22	SS	- gravelly						
70										
		49	SS							
75										
		55	SS	(Old Bridge Sand)	-54.5					
80				Notes: 1. Ground surface elevation at the boring location was surveyed by Williams surveyors.						
85										

(Continued on Sheet 3 of 3)

Completion Depth: 80.0 ft.
Project No.: 60515039
Project Name: Williams NESE Madison
Drilling Method: Hollow Stem Auger + Mud Rotary

Water Depth: See Notes ft., After ____ hrs.
____ ft., After ____ hrs.
____ ft., After ____ hrs.

LOG of BORING No. GB-2

DATE 8/24/2017 SURFACE ELEVATION 25.5 LOCATION Northing: 40.458656 Easting: -74.276231

DEPTH, FT.	SAMPLES	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
90				2. Groundwater level is inferred to be present at approximately 12 feet below existing ground surface based on examination of split-spoon samples and moisture content lab test results. (Groundwater level could not be observed/measured in the boring due to the use of mud rotary drilling methods to advance the boring.) 3. Values under "Pocket Penetrometer" are pocket penetrometer resistance readings in tons per square foot, an indication of unconfined compressive strength of cohesive soils.						
95										
100										
105										
110										
115										
120										
125										
130										

Completion Depth: 80.0 ft. Water Depth: See Notes ft., After ____ hrs.

Project No.: 60515039 ft., After ____ hrs.

Project Name: Williams NESE Madison ft., After ____ hrs.

Drilling Method: Hollow Stem Auger + Mud Rotary ft., After ____ hrs.

10/13/17 WILLIAMS NESE NESE MADISON.GPJ

AECOM

LOG of BORING No. GB-3

DATE 8/22/2017 SURFACE ELEVATION 39.9 LOCATION Northing: 40.45792 Easting: -74.277532

DEPTH, FT.	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
0	15	SS	Dense to very dense brown to orange brown silty coarse to fine SAND with gravel						
	10	SS	(Fill)	35.9					
5	7	SS	Loose to medium dense brown to brownish gray silty fine SAND			16.2	NP	NP	M
	9	SS							
	10	SS				17.8			
10	9	SS				13.6			
15	7	SS				13.5	NP	NP	M
20	5	SS				8.2			
25	12	SS				23.3			M
30	9	SS		7.9					
35	18	SS	Very stiff to hard gray to dark grayish brown CLAY, trace sand		>4.5	15.1	38	20	M
40	34	SS		-1.6	>4.5				
			(Undivided Magothy Unit)						
	19	SS	(Continued on Sheet 2 of 3)						

Completion Depth: 78.4 ft.

Project No.: 60515039

Project Name: Williams NESE Madison

Drilling Method: Hollow Stem Auger + Mud Rotary

Water Depth: See Notes ft., After ___ hrs.

LOG of BORING No. GB-3

DATE 8/22/2017 SURFACE ELEVATION 39.9 LOCATION Northing: 40.45792 Easting: -74.277532

DEPTH, FT.	SAMPLES	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
45				Medium dense to very dense orange brown to light brown silty fine SAND						
50		36	SS				22.5			M
55		30	SS							
60		24	SS	(Undivided Magothy Unit)	-21.6					
65		50/5"	SS	Very dense orange brown to light brown silty coarse to fine SAND						
70		50/5"	SS							
75		50/5"	SS							
		50/5"	SS	(Old Bridge Sand)	-38.5					
80				Notes: 1. Ground surface elevation at the boring location was surveyed by Williams surveyors. 2. Groundwater level is inferred to be present at approximately 22 feet below existing ground surface based on examination of split-spoon samples and moisture content lab test results. (Groundwater level could not be observed/measured in the boring due to the use of mud rotary drilling methods to advance the boring.)						
85				(Continued on Sheet 3 of 3)						

Completion Depth: 78.4 ft. Water Depth: See Notes ft., After ___ hrs.

Project No.: 60515039

Project Name: Williams NESE Madison

Drilling Method: Hollow Stem Auger + Mud Rotary

AECOM

LOG of BORING No. GB-3

DATE 8/22/2017 SURFACE ELEVATION 39.9 LOCATION Northing: 40.45792 Easting: -74.277532

DEPTH, FT.	SAMPLES	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
90				3. Values under "Pocket Penetrometer" are pocket penetrometer resistance readings in tons per square foot, an indication of unconfined compressive strength of cohesive soils.						
95										
100										
105										
110										
115										
120										
125										
130										

Completion Depth: 78.4 ft.

Project No.: 60515039

Project Name: Williams NESE Madison

Drilling Method: Hollow Stem Auger + Mud Rotary

Water Depth: See Notes ft., After ____ hrs.
____ ft., After ____ hrs.
____ ft., After ____ hrs.

10/13/17 WILLIAMS NESE NESE MADISON.GPJ

AECOM

LOG of BORING No. GB-4

DATE 8/9/2017 SURFACE ELEVATION 46.1 LOCATION Northing: 40.4579 Easting: -74.2773

DEPTH, FT.	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
0			Asphalt Pavement	45.6					
			Medium dense orange brown to light brown silty coarse to fine SAND with gravel						
5									
	5	SS							
	12	SS				9.7	NP	NP	M
10	24	SS	- very dense						
15	15	SS				10.1			M
20	12	SS				16.0	NP	NP	M
25	15	SS				9.5			M
			(Fill)	18.6					
			Loose to medium dense light brown to orange brown silty fine SAND						
30	13	SS				13.3			M
	11	SS							
35									
	12	SS				24.6			M
40									
			(Undivided Magothy Unit)						
	7	SS	(Continued on Sheet 2 of 2)						

Completion Depth: 78.9 ft.
Project No.: 60515039
Project Name: Williams NESE Madison
Drilling Method: Hollow Stem Auger + Mud Rotary

Water Depth: See Notes ft., After ___ hrs.
___ ft., After ___ hrs.
___ ft., After ___ hrs.
___ ft., After ___ hrs.

LOG of BORING No. GB-4

DATE 8/9/2017 SURFACE ELEVATION 46.1 LOCATION Northing: 40.4579 Easting: -74.2773

DEPTH, FT.	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
45			- Continuing medium dense light brown to orange brown silty fine SAND						
50	12	SS							
55	27	SS	(Undivided Magothy Unit)	-10.4					
60	21	SS	Medium dense to very dense orange brown to light brown silty medium to fine SAND						
65	33	SS				19.9			M
70	40	SS							
75	58	SS							
80	50/5"	SS	(Old Bridge Sand)	-32.8					
85									

Notes:
1. Ground surface elevation at the boring location was surveyed by Williams surveyors.
2. Groundwater level is inferred to be present at approximately 32 feet below existing ground surface based on examination of split-spoon samples and moisture content lab test results. (Groundwater level could not be observed/measured in the boring due to the use of mud rotary drilling methods to advance the boring.)

Completion Depth: 78.9 ft.
Project No.: 60515039
Project Name: Williams NESE Madison
Drilling Method: Hollow Stem Auger + Mud Rotary

Water Depth: See Notes ft., After ____ hrs.
____ ft., After ____ hrs.
____ ft., After ____ hrs.
____ ft., After ____ hrs.

AECOM

LOG of BORING No. GB-5

DATE 9/11/2017 SURFACE ELEVATION 42.3 LOCATION Northing: 40.458 Easting: -74.2772

DEPTH, FT.	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
0			Asphalt Pavement	41.3					
			Medium dense orange brown to light brown coarse to fine SAND, trace silt and clay						
5				36.3					
	10	SS	Stiff to very stiff gray silty CLAY, trace sand	35.3	2.8	14.4			
	16	SS	Medium dense orange brown to brown silty coarse to fine SAND, trace gravel			12.0			M
10	12	SS				12.7			M
15	10	SS				13.2	NP	NP	M
20	14	SS		21.3	1.6				
			Stiff gray silty CLAY, trace sand						
	P	P		17.3					
25	18	SS	Medium dense to dense brown to dark gray silty coarse to fine SAND						
	29	SS				11.9	NP	NP	M
30			(Fill)	10.8					
			Medium dense to dense light gray to gray silty medium to fine SAND						
	9	SS							
35									
	10	SS				25.4			M
40									
	P	P	(Undivided Magothy Unit)						
	39	SS							

(Continued on Sheet 2 of 3)

Completion Depth: 78.9 ft.
Project No.: 60515039
Project Name: Williams NESE Madison
Drilling Method: Hollow Stem Auger + Mud Rotary

Water Depth: See Notes ft., After ____ hrs.

AECOM

LOG of BORING No. GB-5

DATE 9/11/2017 SURFACE ELEVATION 42.3 LOCATION Northing: 40.458 Easting: -74.2772

DEPTH, FT.	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
45			- Continuing medium dense to dense light gray to gray silty medium to fine SAND						
	12	SS							
50			(Undivided Magothy Unit)	-9.7					
	P	P							
	35	SS	Dense to very dense light gray to orange brown silty medium to fine SAND						
55									
	39	SS				22.2			M
60									
65									
	70	SS							
70									
75									
	50/5"	SS	(Old Bridge Sand)	-36.6					
80			Notes: 1. Ground surface elevation at the boring location was surveyed by Williams surveyors.						
85									

(Continued on Sheet 3 of 3)

Completion Depth: 78.9 ft.
Project No.: 60515039
Project Name: Williams NESE Madison
Drilling Method: Hollow Stem Auger + Mud Rotary

Water Depth: See Notes ft., After ____ hrs.

LOG of BORING No. GB-5

DATE 9/11/2017 SURFACE ELEVATION 42.3 LOCATION Northing: 40.458 Easting: -74.2772

DEPTH, FT.	SAMPLES	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
90				2. Groundwater level is inferred to be present at approximately 31 feet below existing ground surface based on examination of split-spoon samples and moisture content lab test results. (Groundwater level could not be observed/measured in the boring due to the use of mud rotary drilling methods to advance the boring.)						
95				3. Values under "Pocket Penetrometer" are pocket penetrometer resistance readings in tons per square foot, an indication of unconfined compressive strength of cohesive soils.						
100										
105										
110										
115										
120										
125										
130										

Completion Depth: 78.9 ft. Water Depth: See ft., After ___ hrs.

Project No.: 60515039 Notes ft., After ___ hrs.

Project Name: Williams NESE Madison ft., After ___ hrs.

Drilling Method: Hollow Stem Auger + Mud Rotary ft., After ___ hrs.

AECOM

LOG of BORING No. GB-7

DATE 8/8/2017 SURFACE ELEVATION 41.4 LOCATION Northing: 40.4583 Easting: -74.2767

DEPTH, FT.	SAMPLES	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
0				Asphalt Pavement	40.8					
				Medium dense to very dense orange brown to brownish gray silty coarse to fine SAND with gravel						
5										
		25	SS							
		18	SS				7.9			M
10		22	SS				13.4			
15		15	SS				7.6			
20		16	SS				9.4			M
				(Fill)	18.9					
				Loose to medium dense orange brown to grayish brown silty coarse to fine SAND						
25		8	SS				15.1			M
30		4	SS							
		7	SS				27.0			M
35					4.9					
				Very stiff gray silty CLAY						
		19	SS			3.3				
40					-0.1					
				(Undivided Magothy Unit)						
		13	SS	(Continued on Sheet 2 of 3)						

Completion Depth: 80.0 ft.
Project No.: 60515039
Project Name: Williams NESE Madison
Drilling Method: Hollow Stem Auger + Mud Rotary

Water Depth: See Notes ft., After ___ hrs.

LOG of BORING No. GB-7

DATE 8/8/2017 SURFACE ELEVATION 41.4 LOCATION Northing: 40.4583 Easting: -74.2767

DEPTH, FT.	SAMPLES	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
45				Medium dense to very dense gray to orange brown silty medium to fine SAND						
50	■	20	SS							
55	■	35	SS				19.1			M
60	■	40	SS							
65	■	28	SS	(Undivided Magothy Unit)	-25.1					
	■	50/5"	SS	Very dense gray to orange brown silty medium to fine SAND						
70										
	■	50/5"	SS							
75										
80	■	59	SS	(Old Bridge Sand)	-38.6					
				Notes: 1. Ground surface elevation at the boring location was surveyed by Williams surveyors.						
85										

(Continued on Sheet 3 of 3)

Completion Depth: 80.0 ft.

Project No.: 60515039

Project Name: Williams NESE Madison

Drilling Method: Hollow Stem Auger + Mud Rotary

Water Depth: See Notes ft., After ___ hrs.

AECOM

LOG of BORING No. GB-7

Sheet 3 of 3

DATE 8/8/2017 SURFACE ELEVATION 41.4 LOCATION Northing: 40.4583 Easting: -74.2767

DEPTH, FT.	SAMPLES	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
90				2. Groundwater level is inferred to be present at approximately 27 feet below existing ground surface based on examination of split-spoon samples and moisture content lab test results. (Groundwater level could not be observed/measured in the boring due to the use of mud rotary drilling methods to advance the boring.)						
95				3. Values under "Pocket Penetrometer" are pocket penetrometer resistance readings in tons per square foot, an indication of unconfined compressive strength of cohesive soils.						
100										
105										
110										
115										
120										
125										
130										

Completion Depth: 80.0 ft. Water Depth: See Notes ft., After ____ hrs.

Project No.: 60515039 ft., After ____ hrs.

Project Name: Williams NESE Madison ft., After ____ hrs.

Drilling Method: Hollow Stem Auger + Mud Rotary ft., After ____ hrs.

AECOM

LOG of BORING No. MB-1

Sheet 1 of 1

DATE 8/16/2017 SURFACE ELEVATION 46.6 LOCATION Northing: 40.463554 Easting: -74.266146

DEPTH, FT.	SAMPLES	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
0		21	SS	Topsoil	46.3					
				Very dense dark brownish gray to black silty coarse to fine SAND with gravel	44.6					
		9	SS	(Fill)		1.3				
5		5	SS	Stiff to very stiff gray to orange brown silty CLAY		2.5				
		7	SS			1.0				
		4	SS			1.0				
10		9	SS			1.5				
		7	SS	(Amboy Stoneware Clay)	31.6	2.1				
15										
20										
25										
30										
35										
40										

Notes:
1. Ground surface elevation at the boring location was surveyed by Williams surveyors.
2. Groundwater was not encountered during the drilling.
3. Values under "Pocket Penetrometer" are pocket penetrometer resistance readings in tons per square foot, an indication of unconfined compressive strength of cohesive soils.

Completion Depth: 15.0 ft.
Water Depth: See Notes ft., After ___ hrs.
Project No.: 60515039
Project Name: Williams NESE Madison
Drilling Method: Hollow Stem Auger

LOG of BORING No. MDB-1

DATE 8/16/2017-8/17/2017 SURFACE ELEVATION 10.5 LOCATION Northing: 40.46256 Easting: -74.267801

DEPTH, FT.	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
0	6	SS	Medium dense to dense gray to orange brown silty medium to fine SAND						
	12	SS							
5	8	SS							
	5	SS							
	5	SS							
10				-0.5					
	16	SS	Stiff to very stiff light gray to orange brown silty CLAY		4.1	18.8			M
15	14	SS			2.9				
				-7.0					
20	7	SS	Medium dense gray to orange brown silty medium to fine SAND			28.4			M
				-12.0					
25	25	SS	Very stiff dark gray to brownish gray silty CLAY		2.8				
30	39	SS	(Undivided Magothy Unit)						
				-21.5					
35	24	SS	Dense orange brown to brownish gray medium to fine SAND with silt			25.6			M
				-26.0					
40	29	SS	Very stiff to hard dark gray silty CLAY		4.4				
				-31.0					
	18	SS	(Old Bridge Sand)						

(Continued on Sheet 2 of 2)

Completion Depth: 80.0 ft. Water Depth: See Notes ft., After ___ hrs.

Project No.: 60515039

Project Name: Williams NESE Madison

Drilling Method: Hollow Stem Auger + Mud Rotary

AECOM

LOG of BORING No. MDB-1

DATE 8/16/2017-8/17/2017 SURFACE ELEVATION 10.5 LOCATION Northing: 40.46256 Easting: -74.267801

DEPTH, FT.	SAMPLES	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
45				Medium dense to dense orange brown to gray medium to fine SAND with silt, trace gravel						
50	■	11	SS				25.5			M
55	■	47	SS							
60	■	43	SS		-51.0					
				Stiff to very stiff orange brown to gray sandy silty CLAY						
65	■	24	SS		-56.0	2.0	19.6	33	16	
				Medium dense to dense orange brown to light brown coarse to fine SAND, trace silt						
70	■	33	SS							
75	■	19	SS							
80	■	31	SS	(Old Bridge Sand)	-69.5					
85				Notes: 1. Ground surface elevation at the boring location was surveyed by Williams surveyors. 2. Groundwater level was measured at approximately 7.5 ft below existing ground surface on completion of drilling. 3. Values under "Pocket Penetrometer" are pocket penetrometer resistance readings in tons per square foot, an indication of unconfined compressive strength of cohesive soils.						

Completion Depth: 80.0 ft. Water Depth: See Notes ft., After ___ hrs.

Project No.: 60515039 ___ ft., After ___ hrs.

Project Name: Williams NESE Madison ___ ft., After ___ hrs.

Drilling Method: Hollow Stem Auger + Mud Rotary ___ ft., After ___ hrs.

AECOM

Appendix B

Geotechnical Laboratory Testing Results

Project: Williams NESE - Madison
Project No.: 60515039

URS

SUMMARY OF LABORATORY TEST RESULTS

Boring and Sample Number	Depth (feet)	Classification	USCS Symbol	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits		Specific Gravity	Organic Content (%)	Grain Size		Compaction	Consolidation	Unconfined Compression		Triaxial Compression		Permeability (cm/sec)	Special Tests
						Liquid Limit	Plastic Limit			<#200 (%)	<2µ (%)			Stress (psi)	Strain (%)	UU	CIU		
AB-1	8.0-10.0	Brown SILTY SAND	SM	11.7						15									
AB-1	24.0-26.0			28.4						87									
AB-1	48.0-50.0			27.5		38	23												
AB-1	58.0-60.0	Gray SANDY SILT	ML	18.7						57									
AB-2	50.0-52.0	Brown SILTY SAND	SM	23.9						17									
AB-2	55.0-57.0	Dark gray SILT	ML	26.8		42	26			86									
AB-2	60.0-62.0	Dark gray SILT with SAND	ML	22.6						71									
AB-2	70.0-72.0	Gray SILTY SAND	SM	24.4						33									
AB-2	75.0-77.0	Gray SANDY SILT	ML	21.4						54									
AB-2	80.0-82.0	Gray LEAN CLAY with SAND	CL	26.0		35	22			81									
AB-2	85.0-87.0	Gray SILT with SAND	ML	24.4						82									
AB-2	95.0-97.0	Gray SILTY SAND	SM	22.0						19									
AB-3	6.0-8.0	Brown SILTY SAND with GRAVEL	SM	18.8						24									
AB-3	10.0-12.0	Brown SANDY LEAN CLAY	CL	17.4		34	18			60									
AB-3	20.0-22.0	Brown gray SILTY SAND	SM	12.5						30									
AB-3	30.0-32.0	Brown gray SILTY SAND	SM	8.6						16									
AB-3	40.0-42.0	Brown gray SILTY SAND	SM	12.5						25									
AB-3	50.0-52.0	Brown gray SILTY SAND	SM	12.2						27									
AB-3	60.0-62.0	Brown POORLY GRADED SAND with SILT	SP-SM	8.7						11									

Note: The soil classification is based partially on visual classification unless both grain size and Atterberg limits are performed.

* Refer to Laboratory Test Curves

Project: Williams NESE - Madison
Project No.: 60515039

URS

SUMMARY OF LABORATORY TEST RESULTS

Boring and Sample Number	Depth (feet)	Classification	USCS Symbol	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits		Specific Gravity	Organic Content (%)	Grain Size		Compaction	Consolidation	Unconfined Compression		Triaxial Compression		Permeability (cm/sec)	Special Tests
						Liquid Limit	Plastic Limit			<#200 (%)	<2μ (%)			Stress (psi)	Strain (%)	UU	CIU		
AB-3	70.0-72.0	Gray brown SILTY SAND	SM	23.8						19									
AB-3	75.0-77.0	Brown SILTY SAND	SM	12.1						25									
AB-3	80.0-82.0	Brown SILTY SAND	SM	12.0						16									
AB-3	90.0-92.0	Dark gray SILT	ML	30.3		45	29			91									
AB-3	95.0-97.0	Dark gray SANDY SILT	ML	37.9						69									
AB-4	8.0-10.0	Brown SILTY SAND	SM	12.8						17									
AB-4	29.0-31.0	Brown POORLY GRADED SAND with SILT	SP-SM	12.0						12									
AB-4	39.0-41.0			22.6		30	18												
AB-4	78.0-80.0			28.0		43	22												
AB-4	83.0-85.0	Light brown SILTY SAND	SM	17.5						31									
CB-2	4.0-6.0	Brown POORLY GRADED SAND with SILT	SP-SM	5.6						7									
CB-2	14.0-16.0			25.3						45									
CB-2	24.0-26.0	Gray SILTY SAND	SM	22.6						32									
CB-2	29.0-31.0			21.2						71									
CB-2	68.0-70.0	Light brown POORLY GRADED SAND with SILT	SP-SM	22.4						7									
CB-2	78.0-80.0			20.0						65									
CB-2	93.0-95.0			28.5						43									
CB-3	4.0-6.0	Brown gray SILTY SAND	SM	16.5						40									
CB-3	20.0-22.0	Brown SILTY SAND	SM	16.7						19									

Note: The soil classification is based partially on visual classification unless both grain size and Atterberg limits are performed.

* Refer to Laboratory Test Curves

Project: Williams NESE - Madison
Project No.: 60515039

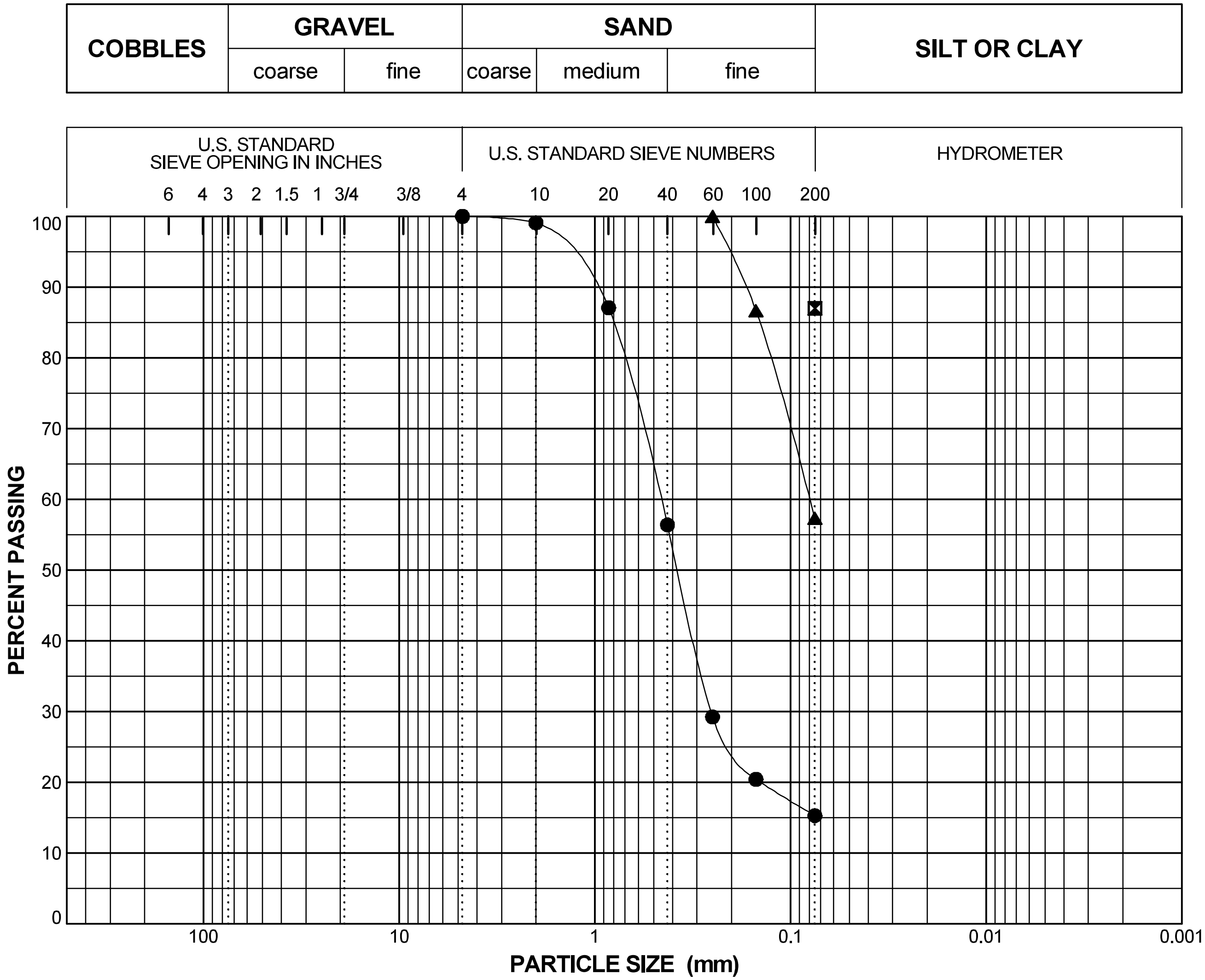
URS

SUMMARY OF LABORATORY TEST RESULTS

Boring and Sample Number	Depth (feet)	Classification	USCS Symbol	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits		Specific Gravity	Organic Content (%)	Grain Size		Compaction	Consolidation	Unconfined Compression		Triaxial Compression		Permeability (cm/sec)	Special Tests
						Liquid Limit	Plastic Limit			<#200 (%)	<2µ (%)			Stress (psi)	Strain (%)	UU	CIU		
CB-3	30.0-32.0	Brown SILT with SAND	ML	5.0						77									
CB-3	35.0-37.0	Brown POORLY GRADED SAND with SILT	SP-SM	3.7						7									
CB-3	45.0-47.0	Brown SILTY SAND	SM	20.2						18									
CB-3	55.0-57.0	Brown SILTY SAND	SM	19.1						23									
CB-3	65.0-67.0	Brown POORLY GRADED SAND with SILT	SP-SM	23.0						9									
CB-3	75.0-77.0	Brown LEAN CLAY with SAND	CL	16.7		29	17			71									
CB-3	80.0-82.0	Brown SILTY SAND	SM	22.4						18									
CB-3	90.0-92.0	Brown POORLY GRADED SAND with SILT	SP-SM	21.0						9									
CB-3	95.0-97.0	Gray SILTY SAND	SM	22.8						48									
CB-3	110.0-112.0	Brown POORLY GRADED SAND with SILT	SP-SM	22.7						8									
MDB-1	10.0-12.0			18.8						55									
MDB-1	19.0-21.0	Brown gray SILTY SAND	SM	28.4						33									
MDB-1	34.0-36.0	Brown POORLY GRADED SAND with SILT	SP-SM	25.6						9									
MDB-1	48.0-50.0	Brown POORLY GRADED SAND with SILT	SP-SM	25.5						7									
MDB-1	63.0-65.0			19.6		33	16												

Note: The soil classification is based partially on visual classification unless both grain size and Atterberg limits are performed.

* Refer to Laboratory Test Curves



SYMBOL	●	⊠	▲
Boring	AB-1	AB-1	AB-1
Sample			
Spec			
Depth (ft)	8.0-10.0	24.0-26.0	58.0-60.0
% +3"	0.0	0.0	0.0
% Gravel	0.0	0.0	0.0
% Sand	84.7	0.0	42.7
% Fines	15.3	87.0	57.3
% -2μ			
Cc			
Cu			
LL			
PL			
PI			
USCS	SM		ML
w (%)	11.7	28.4	18.7

Particle Size (Sieve #)	PERCENT FINER ●	⊠	▲
3"			
2"			
1"			
3/4"			
1/2"			
3/8"			
4	100.0		
10	99.1		
20	87.1		
40	56.4		
60	29.2		100.0
100	20.4		86.7
200	15.3	87.0	57.3

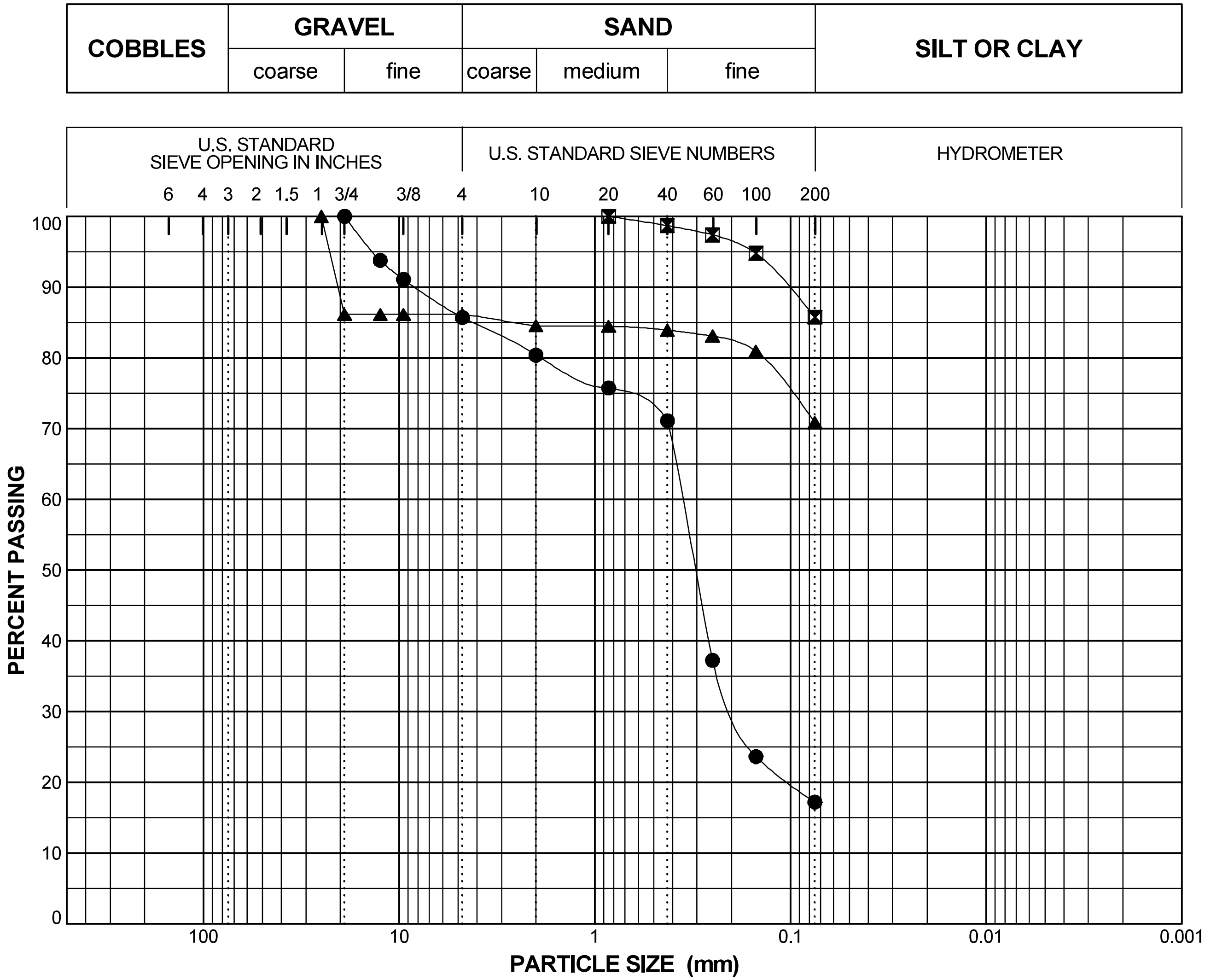
SYMBOL	DESCRIPTION AND REMARKS
●	Brown SILTY SAND (SM)
⊠	Gray ()
▲	Gray SANDY SILT (ML)

PARTICLE SIZE DISTRIBUTION

Williams NESE - Madison

Project Number 60515039 | October 2017 | Figure B-4

URS



SYMBOL	●	⊠	▲
Boring	AB-2	AB-2	AB-2
Sample			
Spec			
Depth (ft)	50.0-52.0	55.0-57.0	60.0-62.0
% +3"	0.0	0.0	0.0
% Gravel	14.3	0.0	13.9
% Sand	68.5	14.3	15.3
% Fines	17.2	85.7	70.8
% -2μ			
Cc			
Cu			
LL		42	
PL		26	
PI		16	
USCS	SM	ML	ML
w (%)	23.9	26.8	22.6

Particle Size (Sieve #)	PERCENT FINER ●	⊠	▲
3"			
2"			
1"			100.0
3/4"	100.0		86.1
1/2"	93.8		86.1
3/8"	91.1		86.1
4	85.7		86.1
10	80.4		84.5
20	75.7	100.0	84.5
40	71.1	98.7	83.9
60	37.2	97.4	83.1
100	23.6	94.8	80.9
200	17.2	85.7	70.8

SYMBOL	DESCRIPTION AND REMARKS
●	Brown SILTY SAND (SM)
⊠	Dark gray SILT (ML)
▲	Dark gray SILT with SAND (ML)

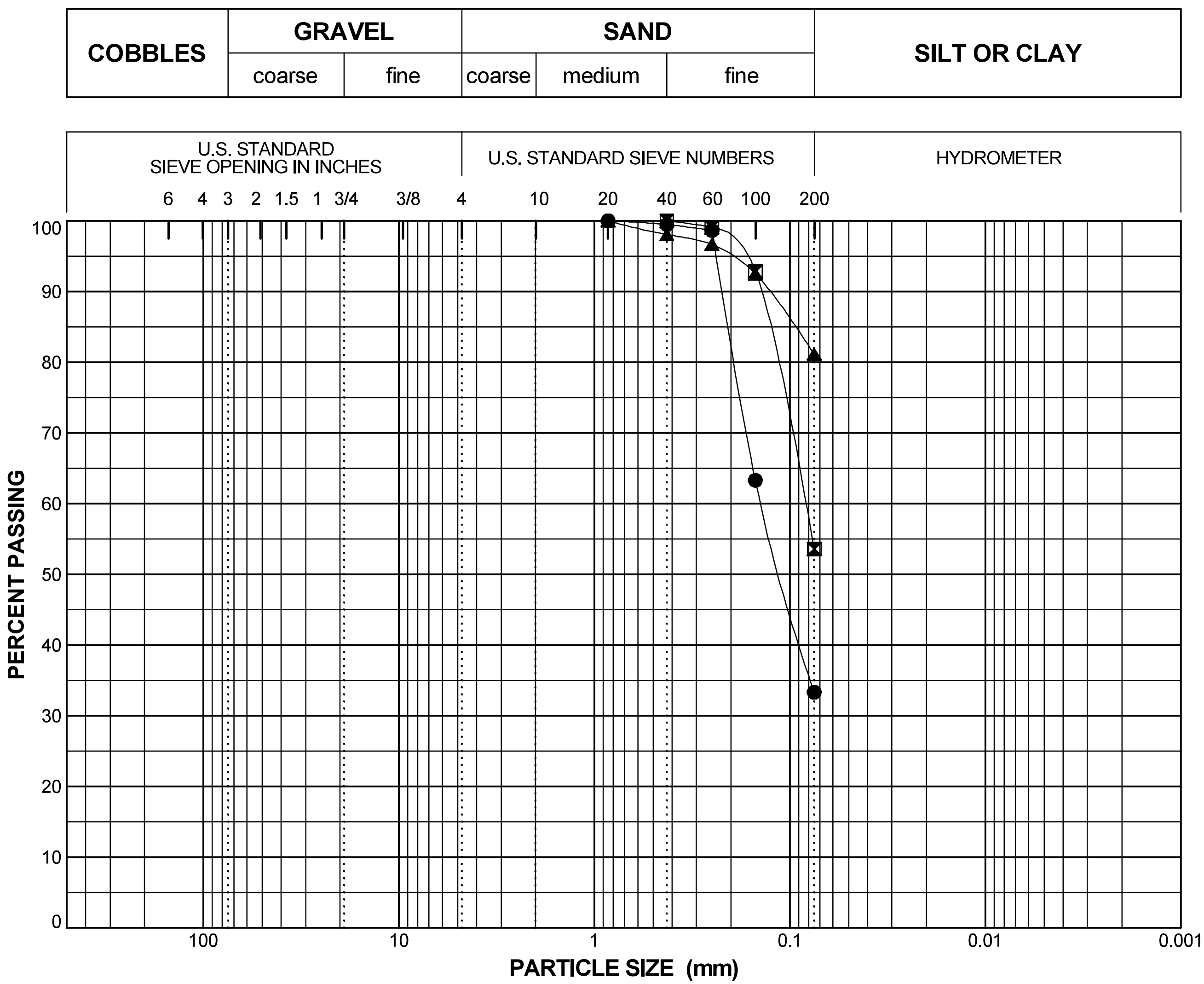
PARTICLE SIZE DISTRIBUTION

Williams NESE - Madison

Project Number 60515039	October 2017	Figure B-5

URS

SIEVE_BLUEBELL_NEW MADISON_LAB.GPJ URS_BLUE.GDT 10/4/17



SYMBOL	DESCRIPTION AND REMARKS
●	Gray SILTY SAND (SM)
⊠	Gray SANDY SILT (ML)
▲	Gray LEAN CLAY with SAND (CL)

SYMBOL	●	⊠	▲
Boring	AB-2	AB-2	AB-2
Sample			
Spec			
Depth (ft)	70.0-72.0	75.0-77.0	80.0-82.0
% +3"	0.0	0.0	0.0
% Gravel	0.0	0.0	0.0
% Sand	66.7	46.4	18.9
% Fines	33.3	53.6	81.1
% -2μ			
Cc			
Cu			
LL			35
PL			22
PI			13
USCS	SM	ML	CL
w (%)	24.4	21.4	26.0

Particle Size (Sieve #)	PERCENT FINER ●	⊠	▲
3"			
2"			
1"			
3/4"			
1/2"			
3/8"			
4			
10			
20	100.0		100.0
40	99.5	100.0	98.1
60	98.6	99.1	96.7
100	63.3	92.9	92.5
200	33.3	53.6	81.1

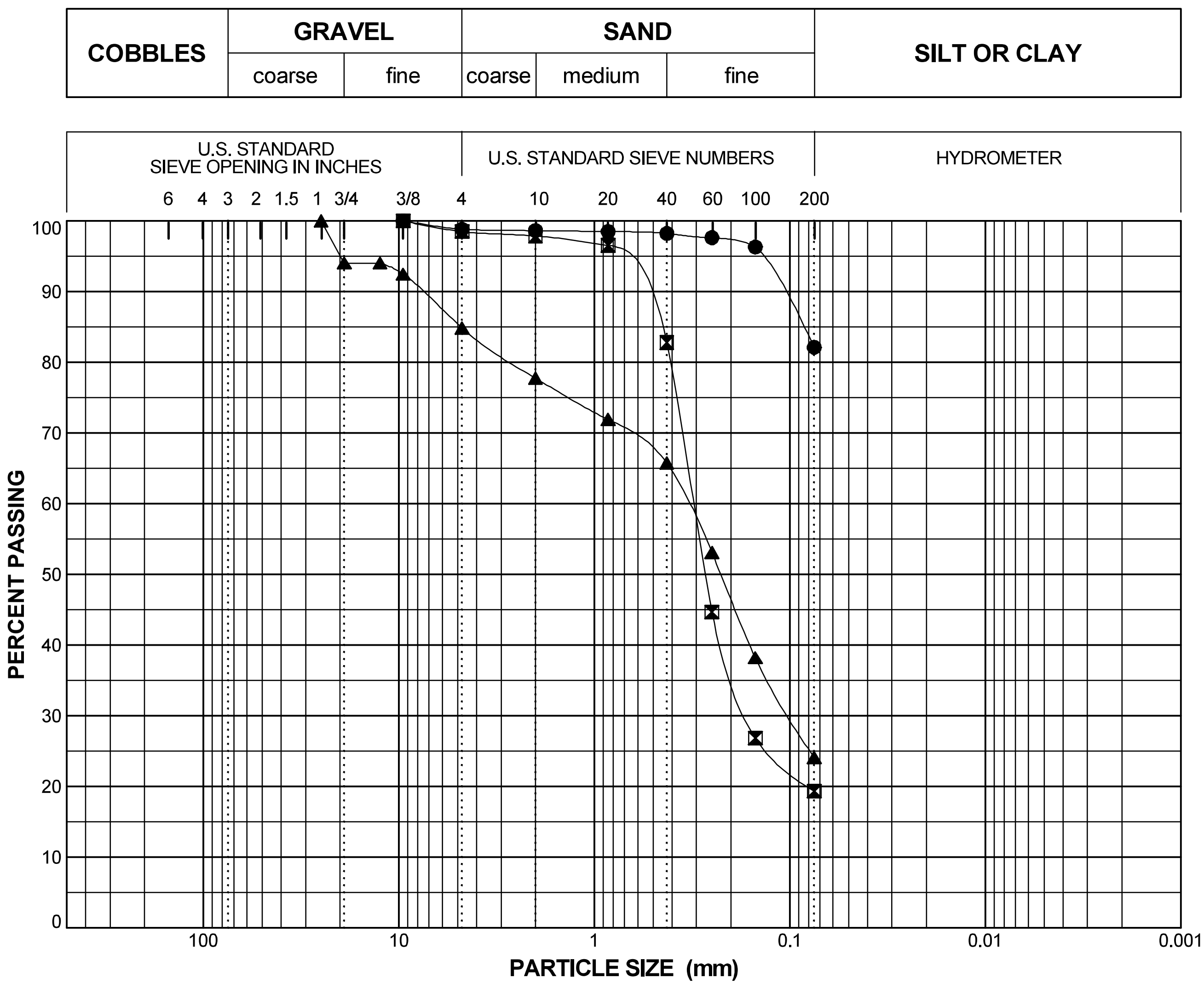
PARTICLE SIZE DISTRIBUTION

Williams NESE - Madison

Project Number 60515039	October 2017	Figure B-6

URS

SIEVE_BLUEBELL_NEW MADISON_LAB.GPJ URS_BLUE.GDT 10/4/17



SYMBOL	●	⊠	▲
Boring	AB-2	AB-2	AB-3
Sample			
Spec			
Depth (ft)	85.0-87.0	95.0-97.0	6.0-8.0
% +3"	0.0	0.0	0.0
% Gravel	1.2	1.5	15.2
% Sand	16.7	79.2	60.7
% Fines	82.1	19.3	24.1
% -2μ			
Cc			
Cu			
LL			
PL			
PI			
USCS	ML	SM	SM
w (%)	24.4	22.0	18.8

Particle Size (Sieve #)	PERCENT FINER ●	⊠	▲
3"			
2"			
1"			100.0
3/4"			94.0
1/2"			94.0
3/8"	100.0	100.0	92.5
4	98.8	98.5	84.8
10	98.6	97.9	77.8
20	98.5	96.5	71.9
40	98.2	82.8	65.7
60	97.6	44.7	53.1
100	96.3	26.8	38.2
200	82.1	19.3	24.1

SYMBOL	DESCRIPTION AND REMARKS
●	Gray SILT with SAND (ML)
⊠	Gray SILTY SAND (SM)
▲	Brown SILTY SAND with GRAVEL (SM)

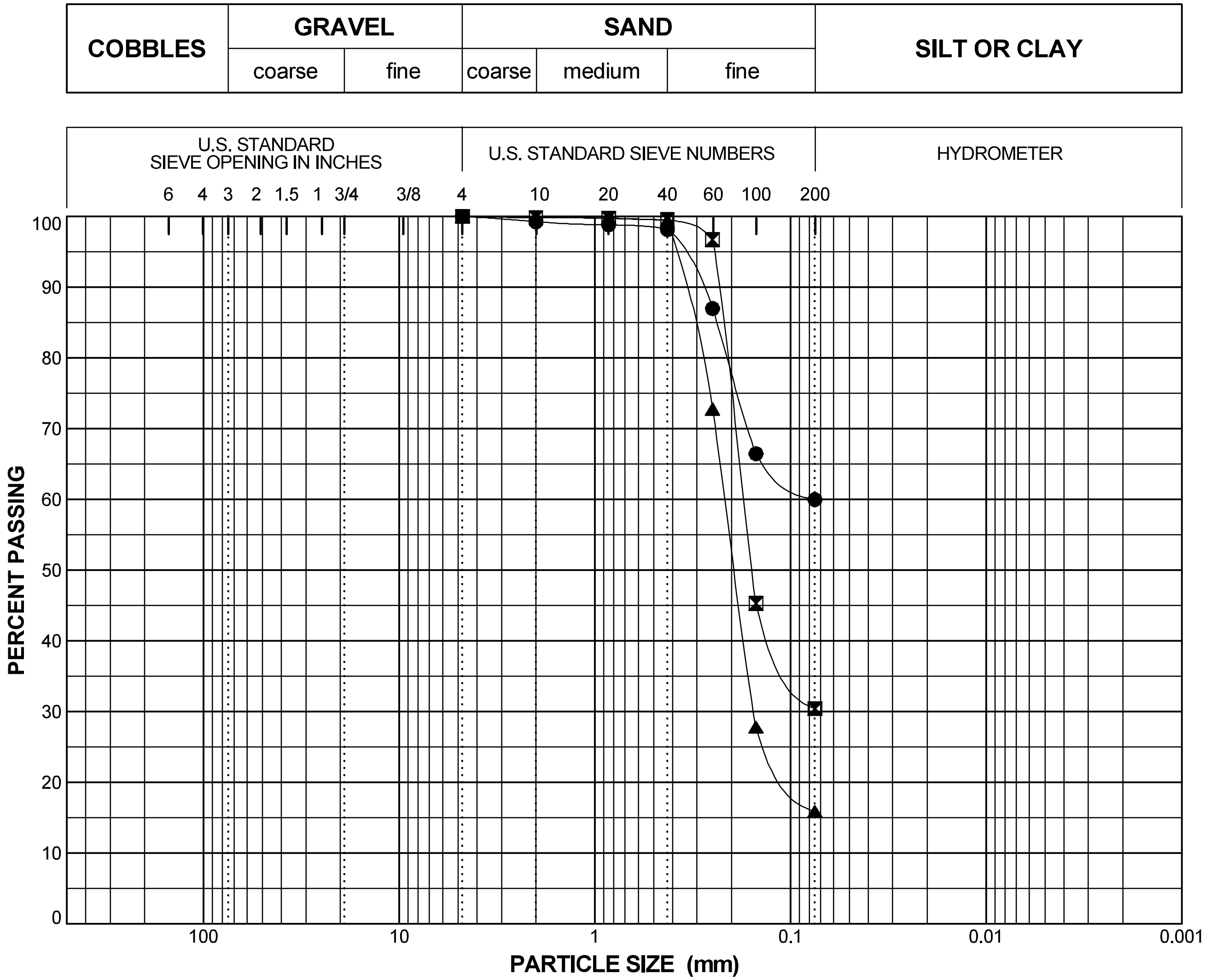
PARTICLE SIZE DISTRIBUTION

Williams NESE - Madison

Project Number 60515039 | October 2017 | Figure B-7

URS

SIEVE_BLUEBELL_NEW MADISON_LAB.GPJ URS_BLUE.GDT 10/4/17



SYMBOL	●	⊠	▲
Boring	AB-3	AB-3	AB-3
Sample			
Spec			
Depth (ft)	10.0-12.0	20.0-22.0	30.0-32.0
% +3"	0.0	0.0	0.0
% Gravel	0.0	0.0	0.0
% Sand	40.0	69.6	84.1
% Fines	60.0	30.4	15.9
% -2μ			
Cc			
Cu			
LL	34		
PL	18		
PI	16		
USCS	CL	SM	SM
w (%)	17.4	12.5	8.6

Particle Size (Sieve #)	PERCENT FINER ●	⊠	▲
3"			
2"			
1"			
3/4"			
1/2"			
3/8"			
4	100.0	100.0	100.0
10	99.2	99.8	99.8
20	98.8	99.7	99.7
40	98.2	99.5	99.5
60	87.0	96.7	72.8
100	66.4	45.3	27.8
200	60.0	30.4	15.9

SYMBOL	DESCRIPTION AND REMARKS
●	Brown SANDY LEAN CLAY (CL)
⊠	Brown gray SILTY SAND (SM)
▲	Brown gray SILTY SAND (SM)

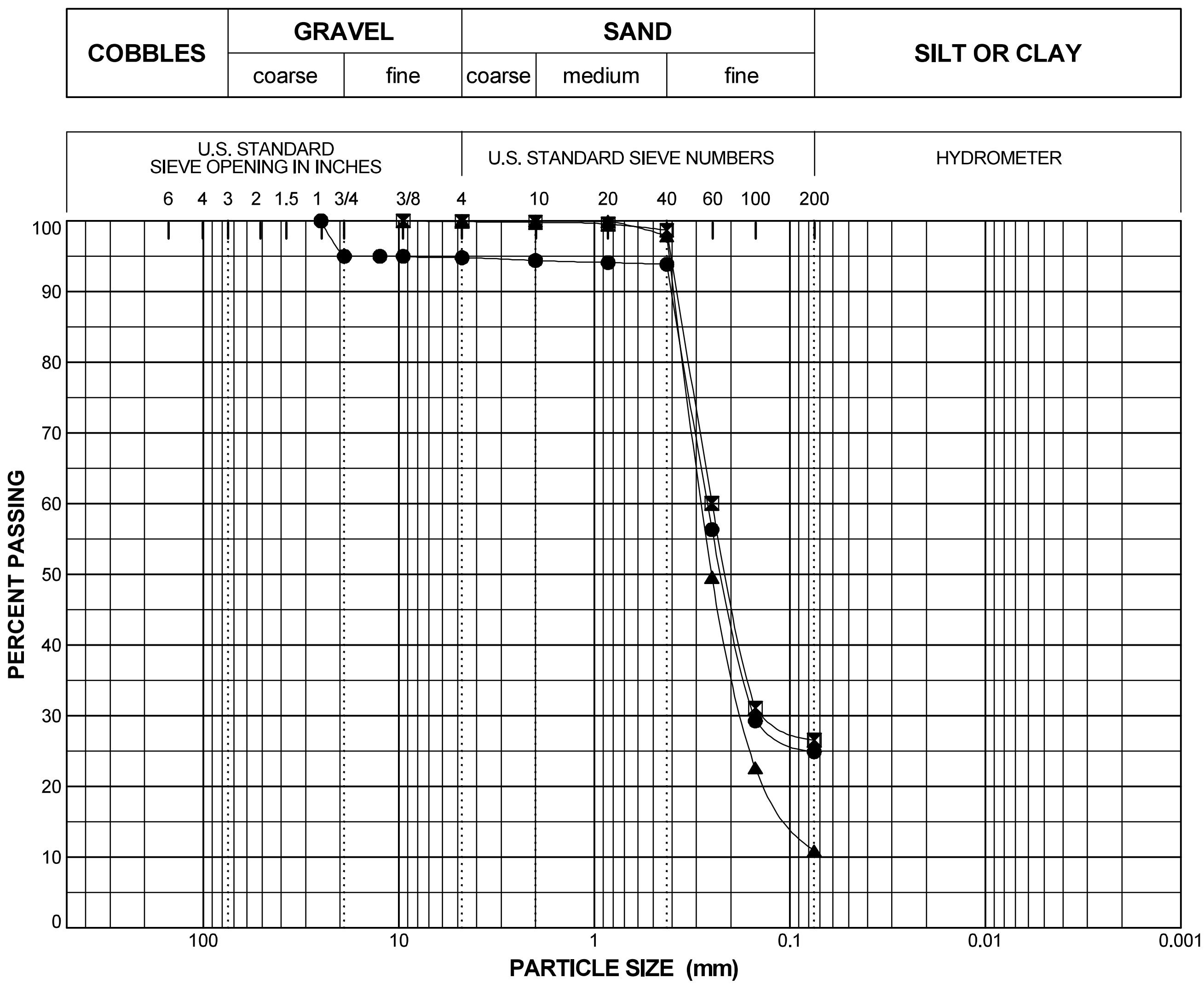
PARTICLE SIZE DISTRIBUTION

Williams NESE - Madison

Project Number 60515039	October 2017	Figure B-8

URS

SIEVE_BLUEBELL_NEW MADISON_LAB.GPJ URS_BLUE.GDT 10/4/17



SYMBOL	●	⊠	▲
Boring	AB-3	AB-3	AB-3
Sample			
Spec			
Depth (ft)	40.0-42.0	50.0-52.0	60.0-62.0
% +3"	0.0	0.0	0.0
% Gravel	5.2	0.1	0.0
% Sand	69.9	73.3	89.1
% Fines	24.9	26.6	10.9
% -2μ			
Cc			1.49
Cu			3.94
LL			
PL			
PI			
USCS	SM	SM	SP-SM
w (%)	12.5	12.2	8.7

Particle Size (Sieve #)	PERCENT FINER ●	⊠	▲
3"			
2"			
1"	100.0		
3/4"	95.0		
1/2"	95.0		
3/8"	95.0	100.0	
4	94.8	99.9	100.0
10	94.4	99.8	100.0
20	94.1	99.5	99.9
40	93.9	98.7	97.9
60	56.3	60.1	49.6
100	29.3	31.1	22.6
200	24.9	26.6	10.9

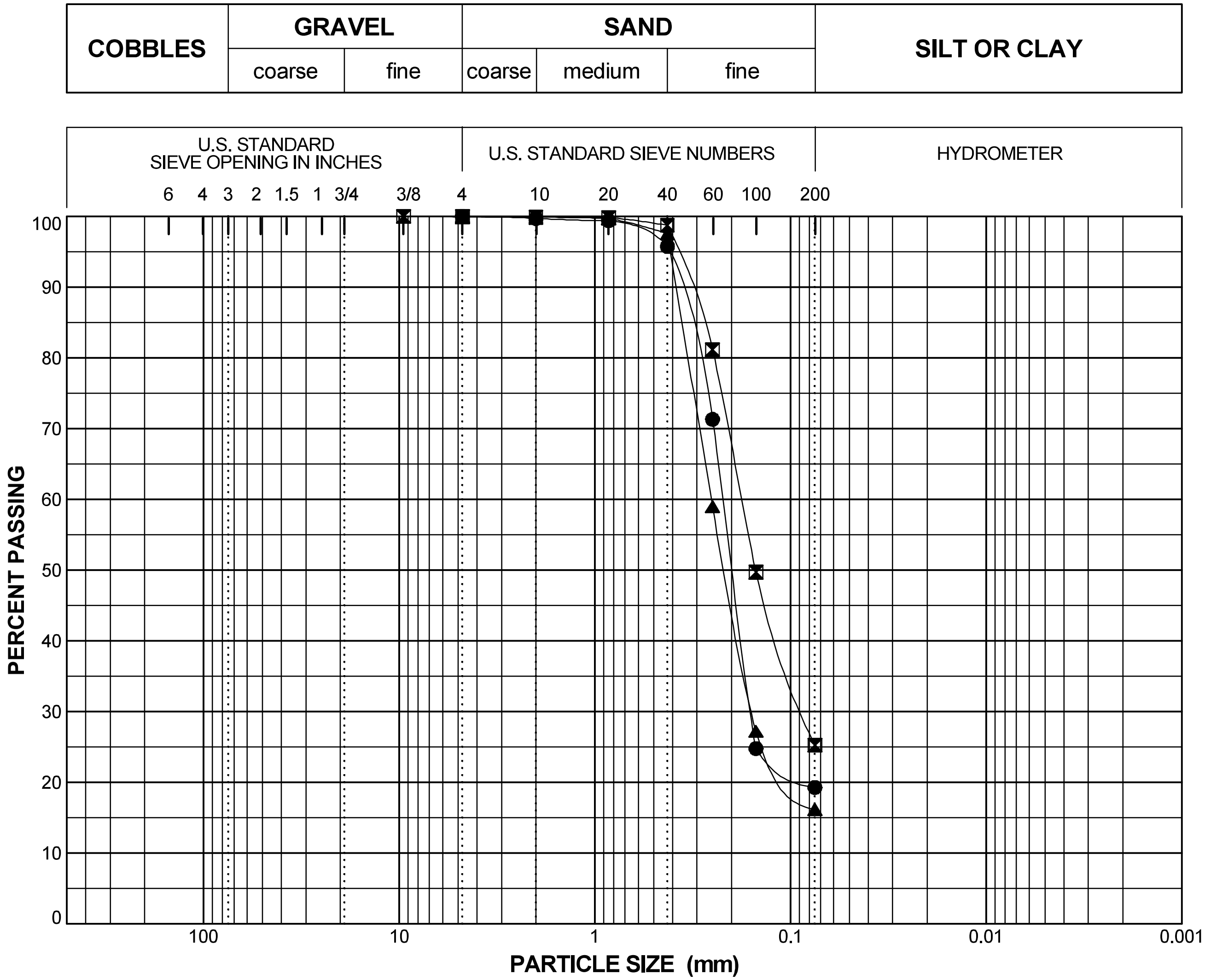
SYMBOL	DESCRIPTION AND REMARKS
●	Brown gray SILTY SAND (SM)
⊠	Brown gray SILTY SAND (SM)
▲	Brown POORLY GRADED SAND with SILT (SP-SM)

PARTICLE SIZE DISTRIBUTION

Williams NESE - Madison

Project Number 60515039	October 2017	Figure B-9

URS



SYMBOL	●	⊠	▲
Boring	AB-3	AB-3	AB-3
Sample			
Spec			
Depth (ft)	70.0-72.0	75.0-77.0	80.0-82.0
% +3"	0.0	0.0	0.0
% Gravel	0.0	0.1	0.0
% Sand	80.7	74.7	83.8
% Fines	19.3	25.3	16.2
% -2μ			
Cc			
Cu			
LL			
PL			
PI			
USCS	SM	SM	SM
w (%)	23.8	12.1	12.0

Particle Size (Sieve #)	PERCENT FINER ●	⊠	▲
3"			
2"			
1"			
3/4"			
1/2"			
3/8"		100.0	
4	100.0	99.9	100.0
10	99.7	99.9	99.9
20	99.4	99.8	99.7
40	95.7	98.7	97.6
60	71.3	81.2	59.0
100	24.8	49.7	27.2
200	19.3	25.3	16.2

SYMBOL	DESCRIPTION AND REMARKS
●	Gray brown SILTY SAND (SM)
⊠	Brown SILTY SAND (SM)
▲	Brown SILTY SAND (SM)

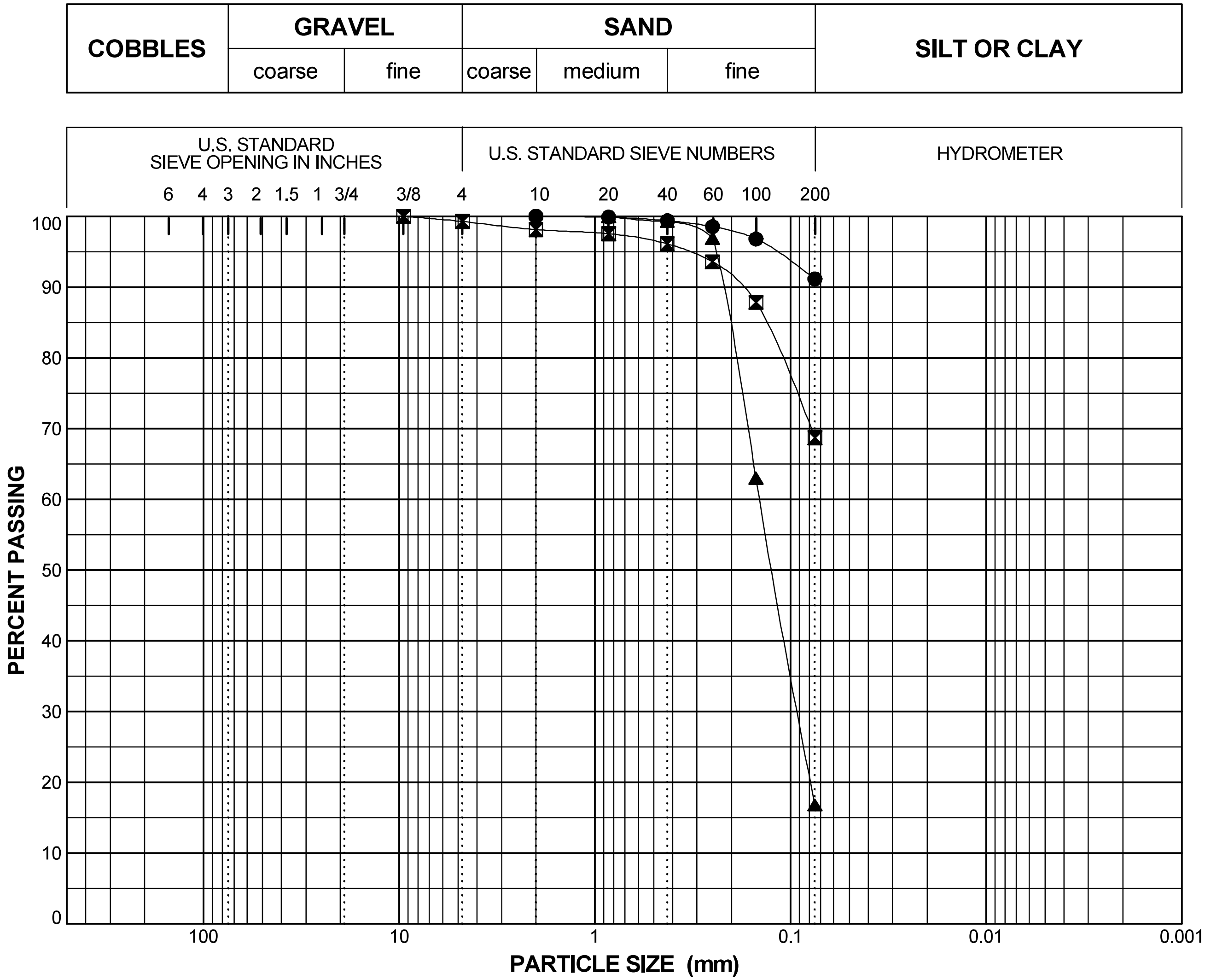
PARTICLE SIZE DISTRIBUTION

Williams NESE - Madison

Project Number 60515039	October 2017	Figure B-10

URS

SIEVE_BLUEBELL_NEW MADISON_LAB.GPJ URS_BLUE.GDT 10/4/17



SYMBOL	●	⊠	▲
Boring	AB-3	AB-3	AB-4
Sample			
Spec			
Depth (ft)	90.0-92.0	95.0-97.0	8.0-10.0
% +3"	0.0	0.0	0.0
% Gravel	0.0	0.7	0.0
% Sand	8.8	30.6	83.2
% Fines	91.2	68.7	16.8
% -2μ			
Cc			
Cu			
LL	45		
PL	29		
PI	16		
USCS	ML	ML	SM
w (%)	30.3	37.9	12.8

Particle Size (Sieve #)	PERCENT FINER ●	⊠	▲
3"			
2"			
1"			
3/4"			
1/2"			
3/8"		100.0	
4		99.3	
10	100.0	98.1	
20	99.9	97.6	100.0
40	99.4	96.1	99.3
60	98.6	93.6	96.9
100	96.8	87.8	63.0
200	91.2	68.7	16.8

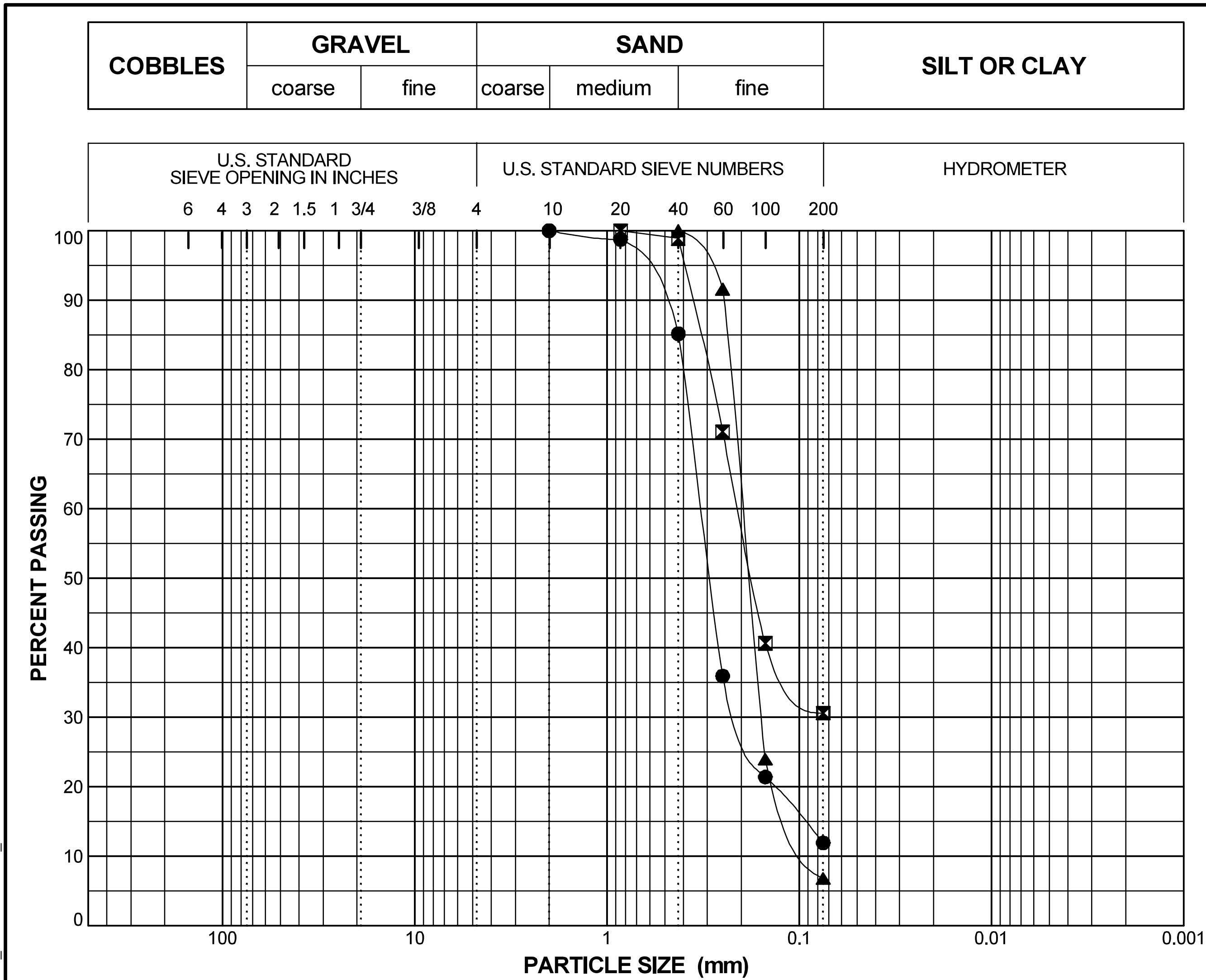
SYMBOL	DESCRIPTION AND REMARKS
●	Dark gray SILT (ML)
⊠	Dark gray SANDY SILT (ML)
▲	Brown SILTY SAND (SM)

PARTICLE SIZE DISTRIBUTION

Williams NESE - Madison

Project Number 60515039	October 2017	Figure B-11

URS



SYMBOL	●	⊠	▲
Boring	AB-4	AB-4	CB-2
Sample			
Spec			
Depth (ft)	29.0-31.0	83.0-85.0	4.0-6.0
% +3"	0.0	0.0	0.0
% Gravel	0.0	0.0	0.0
% Sand	88.1	69.4	93.2
% Fines	11.9	30.6	6.8
% -2μ			
Cc	1.95		1.47
Cu	4.97		2.31
LL			
PL			
PI			
USCS	SP-SM	SM	SP-SM
w (%)	12.0	17.5	5.6

Particle Size (Sieve #)	PERCENT FINER ●	PERCENT FINER ⊠	PERCENT FINER ▲
3"			
2"			
1"			
3/4"			
1/2"			
3/8"			
4			
10	100.0		
20	98.8	100.0	
40	85.2	98.9	100.0
60	35.9	71.1	91.6
100	21.4	40.6	24.0
200	11.9	30.6	6.8

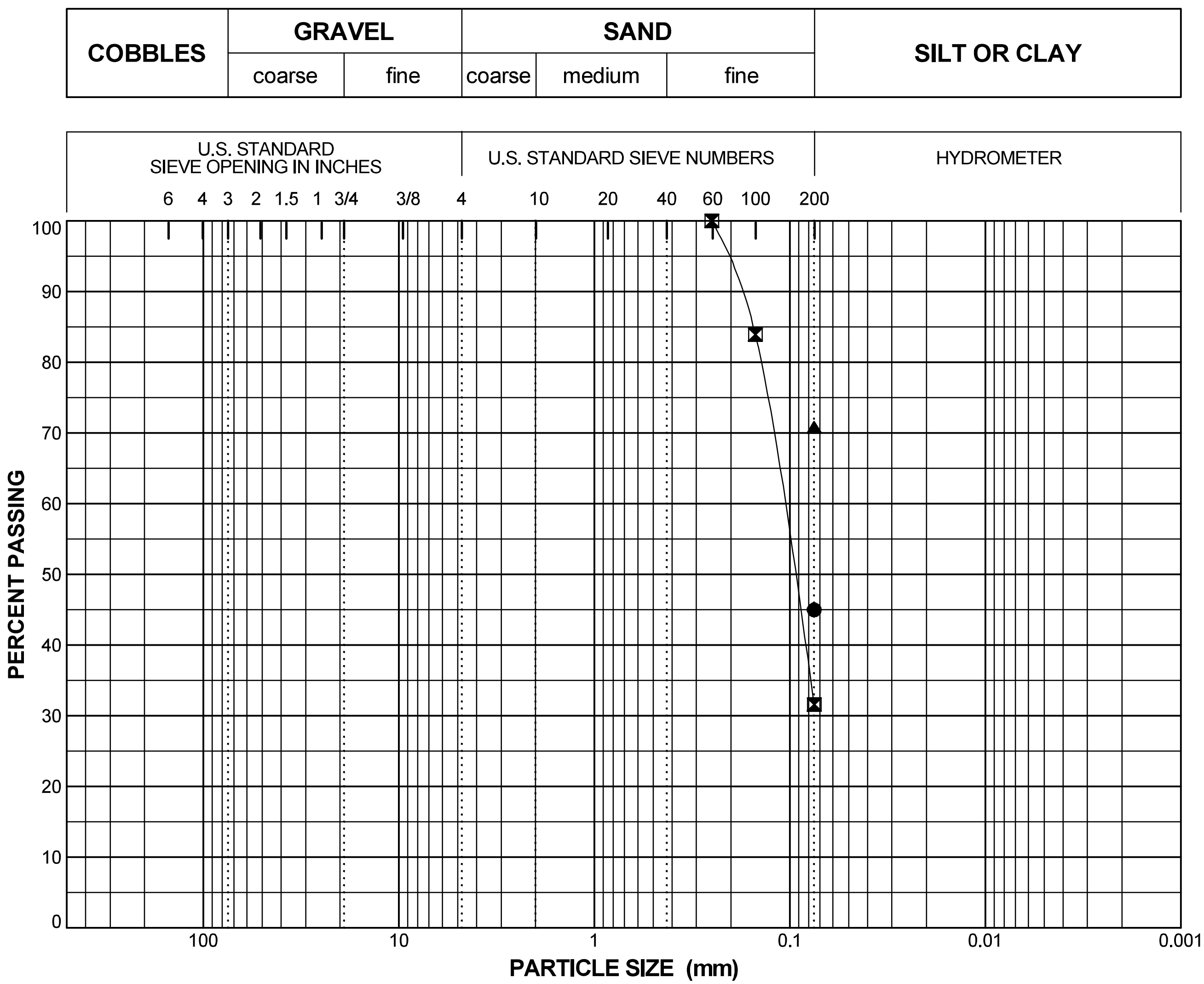
SYMBOL	DESCRIPTION AND REMARKS
●	Brown POORLY GRADED SAND with SILT (SP-SM)
⊠	Light brown SILTY SAND (SM)
▲	Brown POORLY GRADED SAND with SILT (SP-SM)

PARTICLE SIZE DISTRIBUTION

Williams NESE - Madison

Project Number 60515039	October 2017	Figure B-12

URS



SYMBOL	●	⊠	▲
Boring	CB-2	CB-2	CB-2
Sample			
Spec			
Depth (ft)	14.0-16.0	24.0-26.0	29.0-31.0
% +3"	0.0	0.0	0.0
% Gravel	0.0	0.0	0.0
% Sand	0.0	68.4	0.0
% Fines	45.0	31.6	70.8
% -2μ			
Cc			
Cu			
LL			
PL			
PI			
USCS		SM	
w (%)	25.3	22.6	21.2

Particle Size (Sieve #)	PERCENT FINER ●	⊠	▲
3"			
2"			
1"			
3/4"			
1/2"			
3/8"			
4			
10			
20			
40			
60		100.0	
100		83.9	
200	45.0	31.6	70.8

SYMBOL	DESCRIPTION AND REMARKS
●	Gray ()
⊠	Gray SILTY SAND (SM)
▲	Gray ()

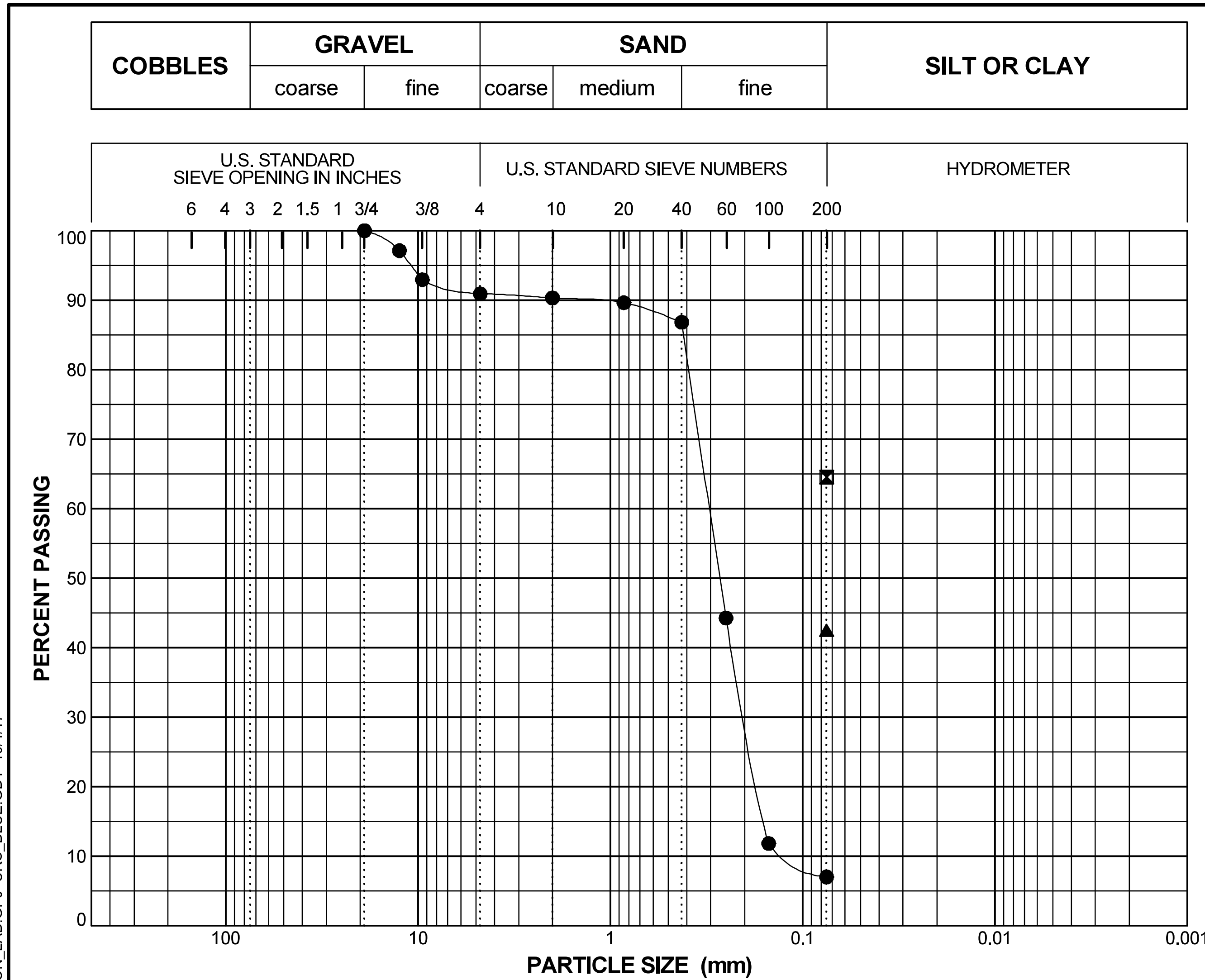
PARTICLE SIZE DISTRIBUTION

Williams NESE - Madison

Project Number 60515039	October 2017	Figure B-13

URS

SIEVE_BLUEBELL_NEW MADISON_LAB.GPJ URS_BLUE.GDT 10/4/17



SYMBOL	●	⊠	▲
Boring	CB-2	CB-2	CB-2
Sample			
Spec			
Depth (ft)	68.0-70.0	78.0-80.0	93.0-95.0
% +3"	0.0	0.0	0.0
% Gravel	9.1	0.0	0.0
% Sand	83.9	0.0	0.0
% Fines	7.0	64.5	42.5
% -2µ			
Cc	1.14		
Cu	2.64		
LL			
PL			
PI			
USCS	SP-SM		
w (%)	22.4	20.0	28.5

Particle Size (Sieve #)	PERCENT FINER ●	PERCENT FINER ⊠	PERCENT FINER ▲
3"			
2"			
1"			
3/4"	100.0		
1/2"	97.1		
3/8"	92.9		
4	90.9		
10	90.3		
20	89.6		
40	86.8		
60	44.3		
100	11.8		
200	7.0	64.5	42.5

SYMBOL	DESCRIPTION AND REMARKS
●	Light brown POORLY GRADED SAND with SILT (SP-SM)
⊠	Light brown ()
▲	Gray ()

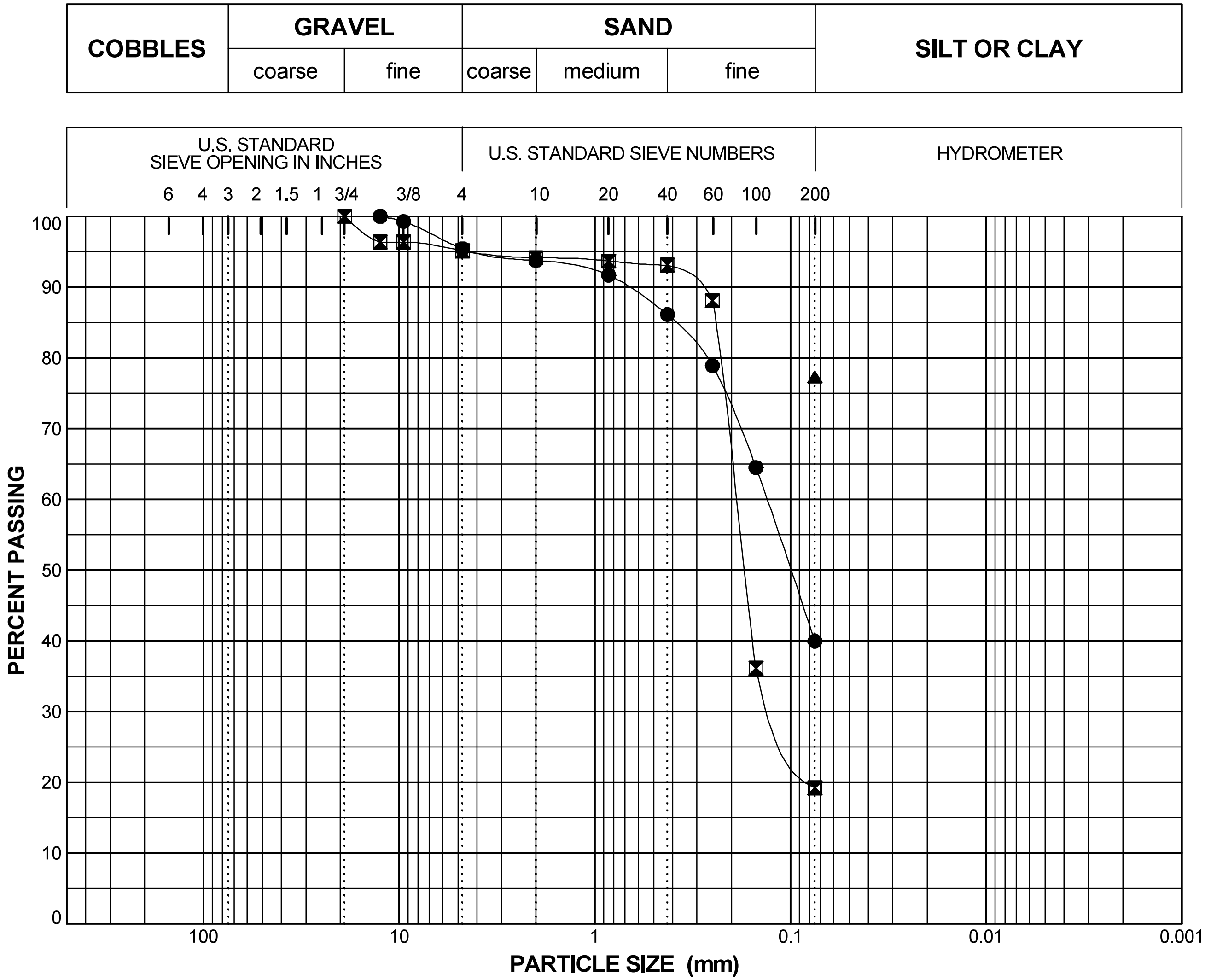
PARTICLE SIZE DISTRIBUTION

Williams NESE - Madison

Project Number 60515039	October 2017	Figure B-14

URS

SIEVE_BLUEBELL_NEW MADISON_LAB.GPJ URS_BLUE.GDT 10/4/17



SYMBOL	●	⊠	▲
Boring	CB-3	CB-3	CB-3
Sample			
Spec			
Depth (ft)	4.0-6.0	20.0-22.0	30.0-32.0
% +3"	0.0	0.0	0.0
% Gravel	4.6	4.9	0.0
% Sand	55.5	75.9	0.0
% Fines	40.0	19.2	77.3
% -2μ			
Cc			
Cu			
LL			
PL			
PI			
USCS	SM	SM	ML
w (%)	16.5	16.7	5.0

Particle Size (Sieve #)	PERCENT FINER ●	⊠	▲
3"			
2"			
1"			
3/4"		100.0	
1/2"	100.0	96.4	
3/8"	99.3	96.4	
4	95.4	95.1	
10	93.8	94.2	
20	91.7	93.7	
40	86.1	93.1	
60	78.9	88.1	
100	64.5	36.1	
200	40.0	19.2	77.3

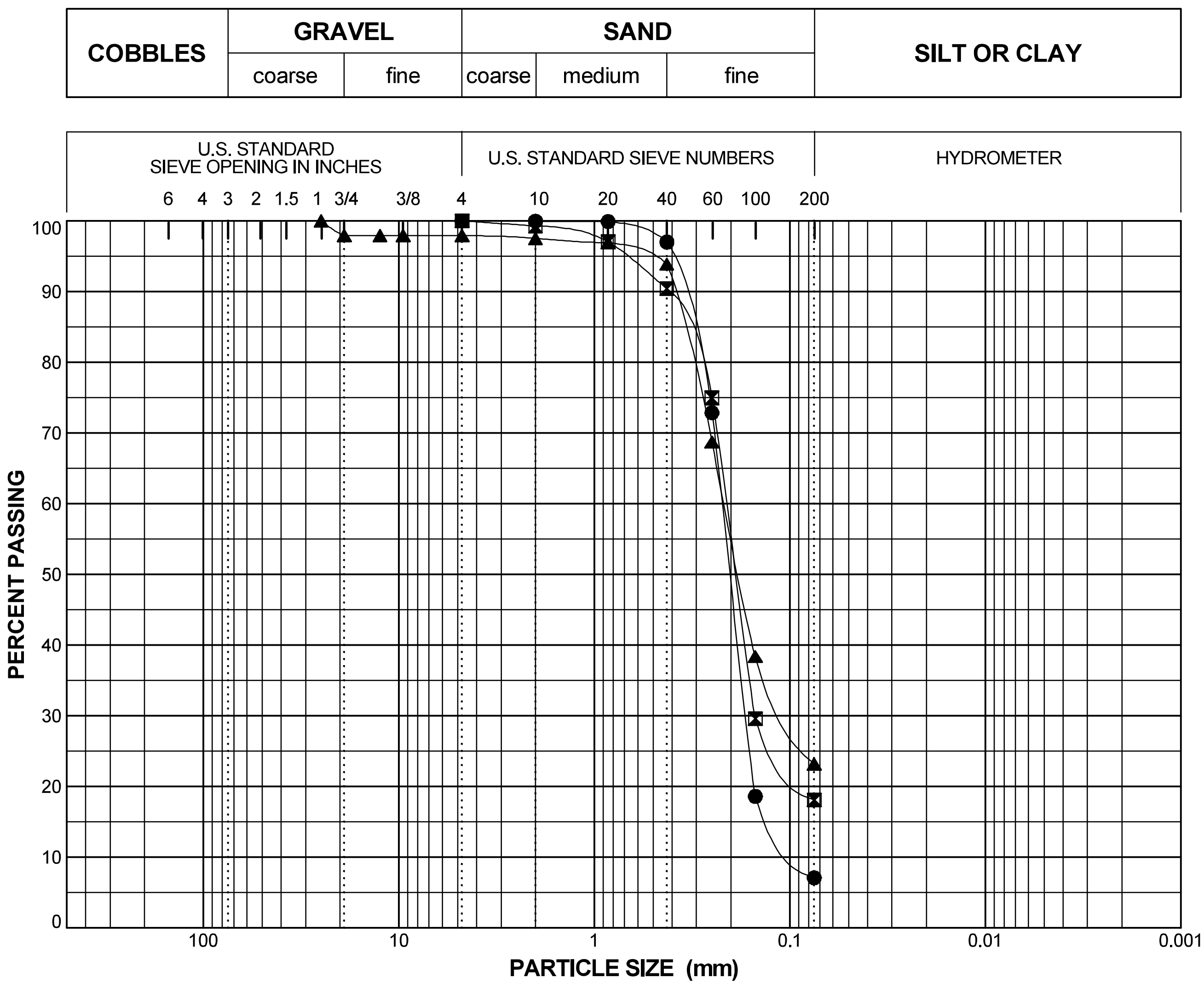
SYMBOL	DESCRIPTION AND REMARKS
●	Brown gray SILTY SAND (SM)
⊠	Brown SILTY SAND (SM)
▲	Brown SILT with SAND (ML)

PARTICLE SIZE DISTRIBUTION

Williams NESE - Madison

Project Number 60515039	October 2017	Figure B-15

URS



SYMBOL	●	⊠	▲
Boring	CB-3	CB-3	CB-3
Sample			
Spec			
Depth (ft)	35.0-37.0	45.0-47.0	55.0-57.0
% +3"	0.0	0.0	0.0
% Gravel	0.0	0.0	2.1
% Sand	92.9	81.9	74.7
% Fines	7.1	18.1	23.2
% -2μ			
Cc	1.41		
Cu	2.48		
LL			
PL			
PI			
USCS	SP-SM	SM	SM
w (%)	3.7	20.2	19.1

Particle Size (Sieve #)	PERCENT FINER ●	⊠	▲
3"			
2"			
1"			100.0
3/4"			97.9
1/2"			97.9
3/8"			97.9
4	100.0	100.0	97.9
10	99.9	99.3	97.5
20	99.9	97.0	96.9
40	97.0	90.4	93.9
60	72.8	75.0	68.7
100	18.6	29.6	38.4
200	7.1	18.1	23.2

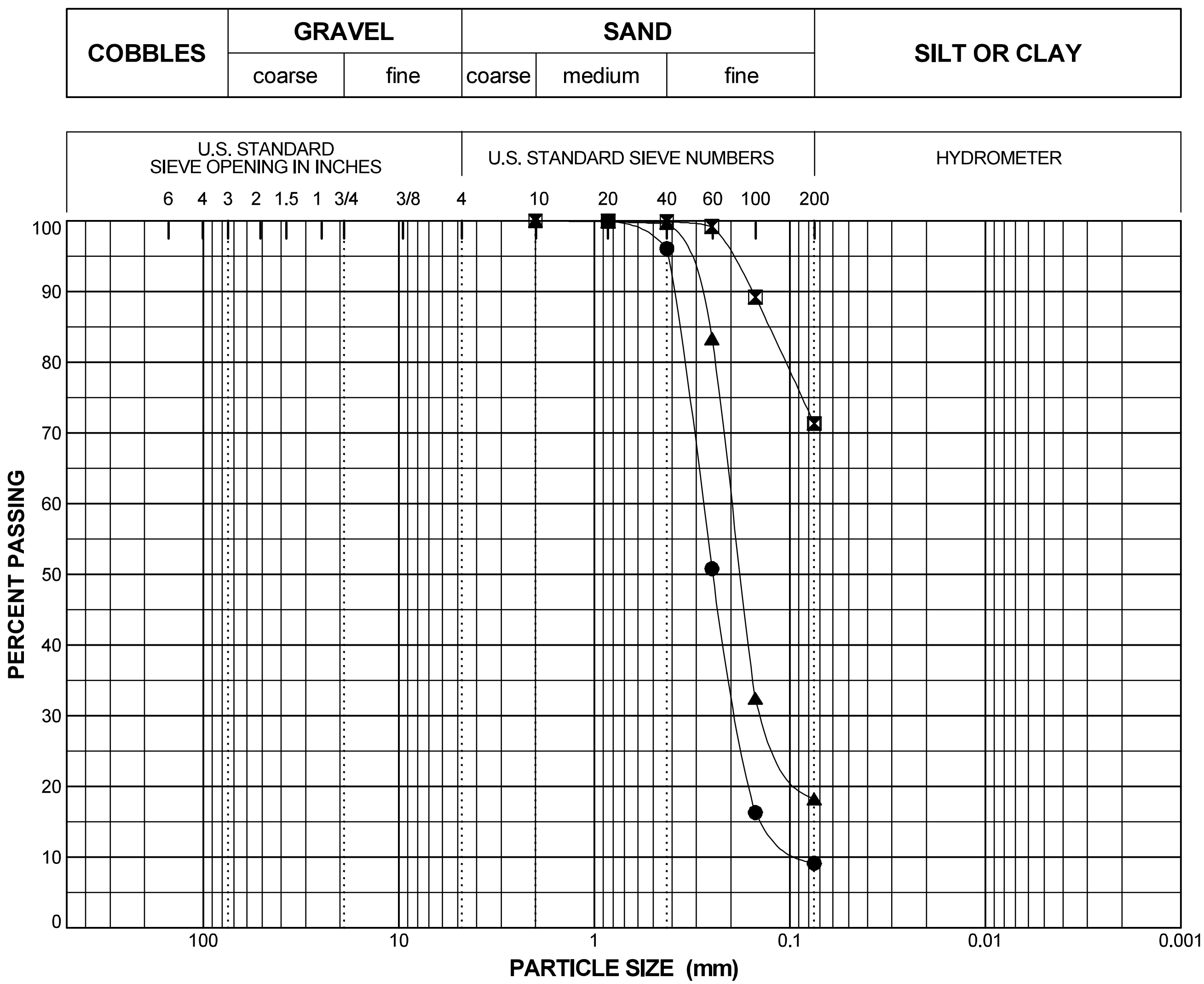
SYMBOL	DESCRIPTION AND REMARKS
●	Brown POORLY GRADED SAND with SILT (SP-SM)
⊠	Brown SILTY SAND (SM)
▲	Brown SILTY SAND (SM)

PARTICLE SIZE DISTRIBUTION

Williams NESE - Madison

Project Number 60515039	October 2017	Figure B-16

URS



SYMBOL	●	⊠	▲
Boring	CB-3	CB-3	CB-3
Sample			
Spec			
Depth (ft)	65.0-67.0	75.0-77.0	80.0-82.0
% +3"	0.0	0.0	0.0
% Gravel	0.0	0.0	0.0
% Sand	90.9	28.7	81.8
% Fines	9.1	71.3	18.2
% -2μ			
Cc	1.48		
Cu	3.41		
LL		29	
PL		17	
PI		12	
USCS	SP-SM	CL	SM
w (%)	23.0	16.7	22.4

Particle Size (Sieve #)	PERCENT FINER ●	⊠	▲
3"			
2"			
1"			
3/4"			
1/2"			
3/8"			
4			
10		100.0	100.0
20	100.0	99.9	99.9
40	96.1	99.9	99.6
60	50.8	99.2	83.3
100	16.3	89.2	32.4
200	9.1	71.3	18.2

SYMBOL	DESCRIPTION AND REMARKS
●	Brown POORLY GRADED SAND with SILT (SP-SM)
⊠	Brown LEAN CLAY with SAND (CL)
▲	Brown SILTY SAND (SM)

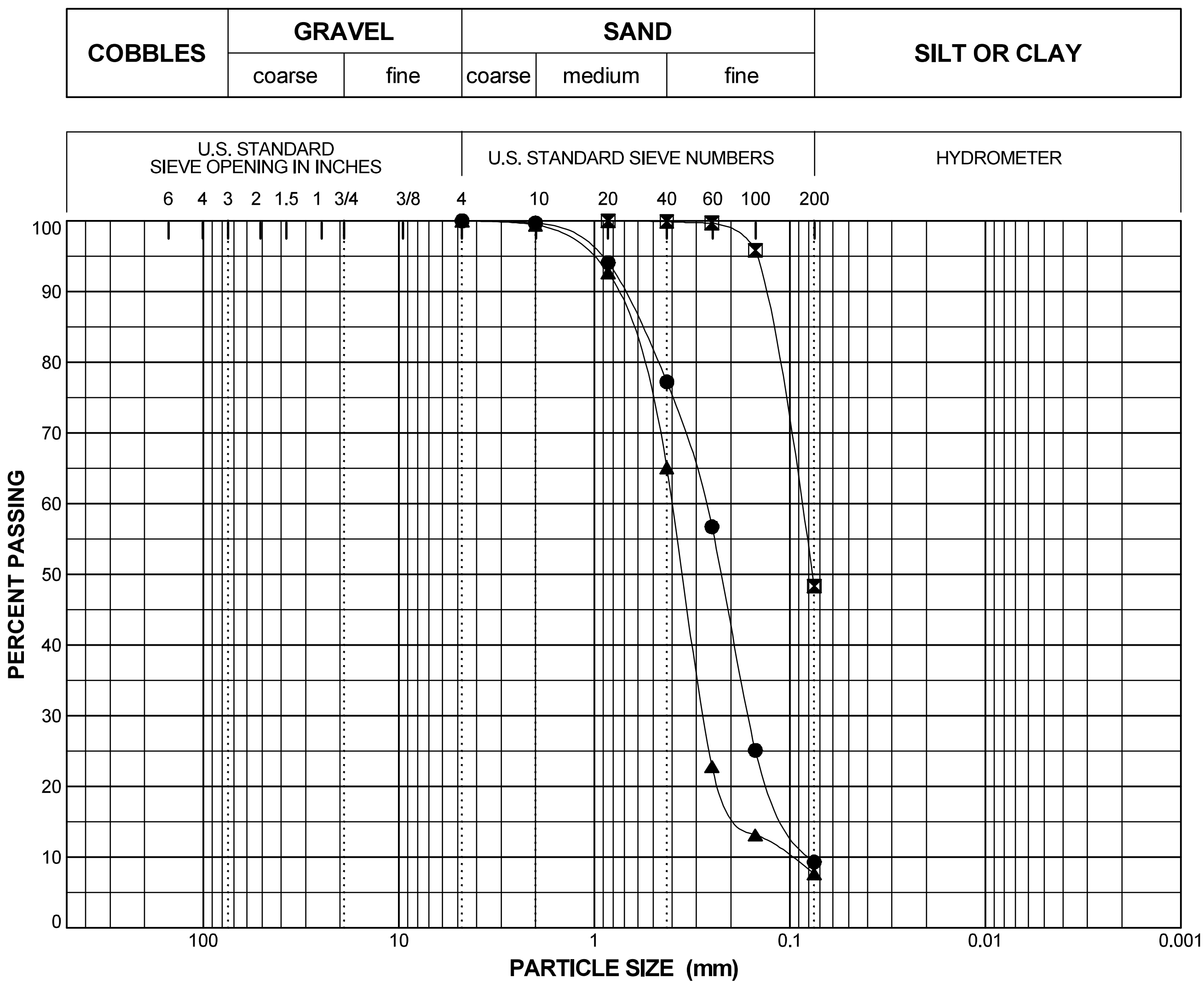
PARTICLE SIZE DISTRIBUTION

Williams NESE - Madison

Project Number 60515039	October 2017	Figure B-17

URS

SIEVE_BLUEBELL_NEW MADISON_LAB.GPJ URS_BLUE.GDT 10/4/17



SYMBOL	●	⊠	▲
Boring	CB-3	CB-3	CB-3
Sample			
Spec			
Depth (ft)	90.0-92.0	95.0-97.0	110.0-112.0
% +3"	0.0	0.0	0.0
% Gravel	0.0	0.0	0.0
% Sand	90.7	51.7	92.4
% Fines	9.3	48.4	7.6
% -2µ			
Cc	1.25		1.86
Cu	3.52		3.94
LL			
PL			
PI			
USCS	SP-SM	SM	SP-SM
w (%)	21.0	22.8	22.7

Particle Size (Sieve #)	PERCENT FINER ●	⊠	▲
3"			
2"			
1"			
3/4"			
1/2"			
3/8"			
4	100.0		100.0
10	99.7		99.4
20	94.1	100.0	92.7
40	77.2	99.9	65.1
60	56.7	99.7	22.8
100	25.1	95.9	13.1
200	9.3	48.4	7.6

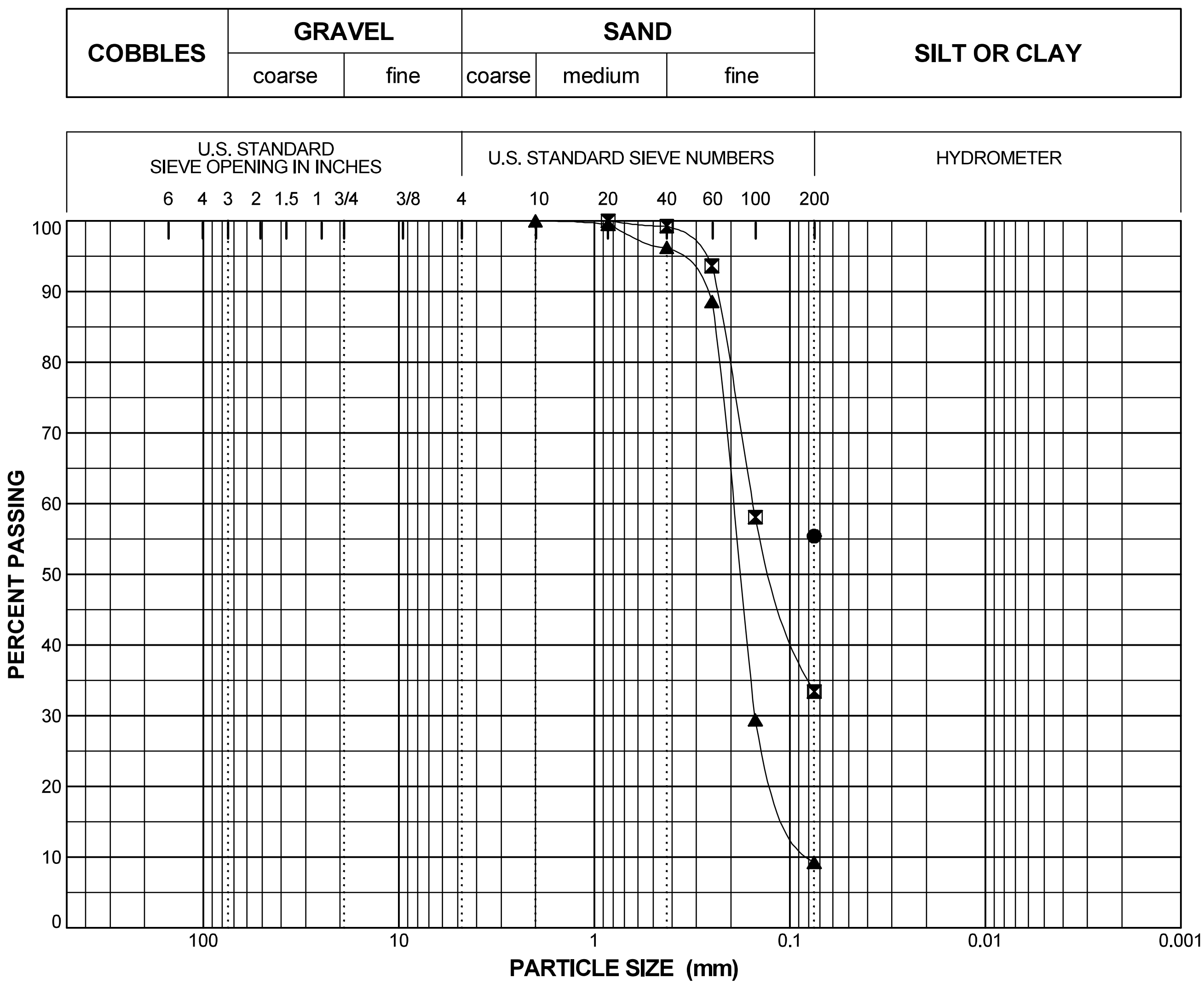
SYMBOL	DESCRIPTION AND REMARKS
●	Brown POORLY GRADED SAND with SILT (SP-SM)
⊠	Gray SILTY SAND (SM)
▲	Brown POORLY GRADED SAND with SILT (SP-SM)

PARTICLE SIZE DISTRIBUTION

Williams NESE - Madison

Project Number 60515039	October 2017	Figure B-18

URS



SYMBOL	●	⊠	▲
Boring	MDB-1	MDB-1	MDB-1
Sample			
Spec			
Depth (ft)	10.0-12.0	19.0-21.0	34.0-36.0
% +3"	0.0	0.0	0.0
% Gravel	0.0	0.0	0.0
% Sand	0.0	66.6	90.8
% Fines	55.4	33.4	9.2
% -2µ			
Cc			1.51
Cu			2.54
LL			
PL			
PI			
USCS		SM	SP-SM
w (%)	18.8	28.4	25.6

Particle Size (Sieve #)	PERCENT FINER ●	⊠	▲
3"			
2"			
1"			
3/4"			
1/2"			
3/8"			
4			
10			100.0
20		100.0	99.5
40		99.2	96.2
60		93.6	88.6
100		58.1	29.4
200	55.4	33.4	9.2

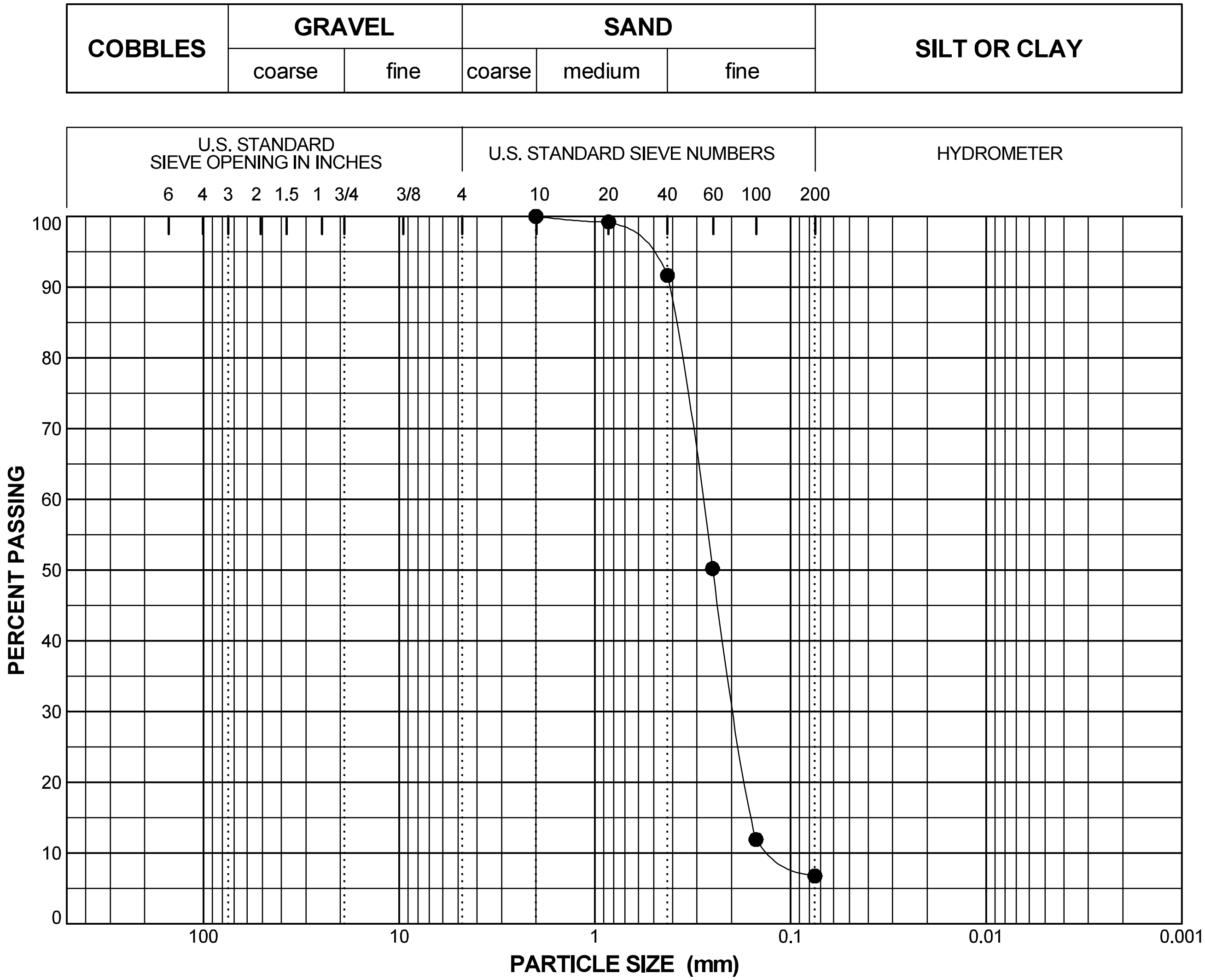
SYMBOL	DESCRIPTION AND REMARKS
●	Brown ()
⊠	Brown gray SILTY SAND (SM)
▲	Brown POORLY GRADED SAND with SILT (SP-SM)

PARTICLE SIZE DISTRIBUTION

Williams NESE - Madison

Project Number 60515039	October 2017	Figure B-19

URS



SYMBOL	●		
Boring	MDB-1		
Sample			
Spec			
Depth (ft)	48.0-50.0		
% +3"	0.0		
% Gravel	0.0		
% Sand	93.2		
% Fines	6.8		
% -2μ			
Cc	1.11		
Cu	2.44		
LL			
PL			
PI			
USCS	SP-SM		
w (%)	25.5		

Particle Size (Sieve #)	PERCENT FINER ●		
3"			
2"			
1"			
3/4"			
1/2"			
3/8"			
4			
10	100.0		
20	99.2		
40	91.6		
60	50.2		
100	11.9		
200	6.8		

SYMBOL	DESCRIPTION AND REMARKS
●	Brown POORLY GRADED SAND with SILT (SP-SM)

PARTICLE SIZE DISTRIBUTION

Williams NESE - Madison

Project Number 60515039	October 2017	Figure B-20

URS

LOG of BORING No. GB-1

DATE 9/26/2016-9/27/2016 SURFACE ELEVATION 40.0 LOCATION Northing: 40.45770783 Easting: -74.27776781

DEPTH, FT.	SAMPLES	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
0		19	SS	TOPSOIL	39.7					
		10	SS	Very loose to medium dense light brown to orange brown silty medium to fine SAND						
5		4	SS				13.2			M
		4	SS							
		4	SS							
10		4	SS				17.1			M
15		6	SS	- trace gravel			17.3			M
20		6	SS				13.0			M
25		5	SS							
30		3	SS				21.1			M
35		12	SS		1.5					
40		10	SS	Stiff to hard gray CLAY, trace sand (Undivided Magothy Unit)	-3.5	>4.5	15.0	34	17	M

(Continued on Sheet 2 of 3)

Completion Depth: 122.0 ft. Water Depth: See Notes ft., After ____ hrs.

Project No.: 60515039 ft., After ____ hrs.

Project Name: Williams NESE Madison ft., After ____ hrs.

Drilling Method: Hollow Stem Auger ft., After ____ hrs.

AECOM

LOG of BORING No. GB-1

DATE 9/26/2016-9/27/2016 SURFACE ELEVATION 40.0 LOCATION Northing: 40.45770783 Easting: -74.27776781

DEPTH, FT.	SAMPLES	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
45		28	SS	Medium dense gray sandy SILT			18.1			M
					-8.5					
50		14	SS	Medium dense to very dense gray to orange brown silty medium to fine SAND			22.1			M
55		16	SS							
60		26	SS							
					-23.5					
65		17	SS	Very stiff gray to brown SILT, trace sand			22.6			M
				(Undivided Magothy Unit)	-28.5					
70		95/11"	SS	Dense to very dense brown to orange brown medium to fine SAND with silt						
75		50/5"	SS							
80		75	SS				21.8			M
85		42	SS							
				(Old Bridge Sand)						

(Continued on Sheet 3 of 3)

Completion Depth: 122.0 ft. Water Depth: See Notes ft., After ___ hrs.

Project No.: 60515039

Project Name: Williams NESE Madison

Drilling Method: Hollow Stem Auger

LOG of BORING No. GB-1

Sheet 3 of 3

DATE 9/26/2016-9/27/2016 SURFACE ELEVATION 40.0 LOCATION Northing: 40.45770783 Easting: -74.27776781

DEPTH, FT.	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
90	10	SS	- Continuing loose to very dense brown to orange brown medium to fine SAND with silt			21.3			M
95	20	SS							
100	27	SS							
105	34	SS				22.0			M
110	27	SS		-73.5					
115	37	SS	Hard gray and light brown silty CLAY with sand	-78.5	3.6				
120	50/5"	SS	Very dense orange brown and gray medium to fine SAND (Old Bridge Sand)	-82.0					
125									
130									

Notes:
1. Ground surface elevation at the boring location was surveyed by Williams surveyors.
2. Groundwater levels were measured as shown below:

Date & Time	GW Depth (ft)	GW Elev. (ft)
09/26/16 10:15	31.0	9.0
09/27/16 08:30	29.4	10.6

3. Values under "Pocket Penetrometer" are pocket penetrometer resistance readings in tons per square foot, an indication of unconfined compressive strength of cohesive soils.

Completion Depth: 122.0 ft. Water Depth: See Notes ft., After hrs.
Project No.: 60515039
Project Name: Williams NESE Madison
Drilling Method: Hollow Stem Auger

AECOM

LOG of BORING No. GB-2

DATE 8/24/2017 SURFACE ELEVATION 25.5 LOCATION Northing: 40.458656 Easting: -74.276231

DEPTH, FT.	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
0	4	SS	Medium dense light gray to orange brown fine SAND with silt						
	7	SS							
5	7	SS				9.8			
	9	SS							
	8	SS				8.3			M
10	7	SS							
15	8	SS		8.0		26.5			M
20	8	SS	Medium dense dark grayish brown to dark gray silty fine SAND	0.5		28.9	NP	NP	M
25	14	SS	Medium dense gray silty fine SAND	-2.0					
30	20	SS	Medium dense to dense grayish brown to brown silty coarse to fine SAND with gravel	-6.5	0.5	16.4	NP	NP	M
35	52	SS	Very dense gray to orange brown fine SAND with silt	-11.0		24.6			M
			Medium dense gray to dark gray sandy SILT	-13.5					
40	22	SS	Very stiff gray to dark gray sandy silty CLAY	-16.0	3.5				
	8	SS	(Undivided Magothy Unit)						

(Continued on Sheet 2 of 3)

Completion Depth: 80.0 ft.
Water Depth: See Notes ft., After ___ hrs.
Project No.: 60515039
Project Name: Williams NESE Madison
Drilling Method: Hollow Stem Auger + Mud Rotary

AECOM

LOG of BORING No. GB-2

DATE 8/24/2017 SURFACE ELEVATION 25.5 LOCATION Northing: 40.458656 Easting: -74.276231

DEPTH, FT.	SAMPLES	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
45				Medium dense to very dense gray to orange brown medium to fine SAND with silt						
50	■	30	SS				24.4			M
55	■	25	SS							
60	■	27	SS							
65	■	38	SS							
70	■	22	SS	- gravelly						
75	■	49	SS							
80	■	55	SS	(Old Bridge Sand)	-54.5					
85				Notes: 1. Ground surface elevation at the boring location was surveyed by Williams surveyors.						

(Continued on Sheet 3 of 3)

Completion Depth: 80.0 ft. Water Depth: See Notes ft., After ___ hrs.

Project No.: 60515039

Project Name: Williams NESE Madison

Drilling Method: Hollow Stem Auger + Mud Rotary

LOG of BORING No. GB-2

DATE 8/24/2017 SURFACE ELEVATION 25.5 LOCATION Northing: 40.458656 Easting: -74.276231

DEPTH, FT.	SAMPLES	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
90				2. Groundwater level is inferred to be present at approximately 12 feet below existing ground surface based on examination of split-spoon samples and moisture content lab test results. (Groundwater level could not be observed/measured in the boring due to the use of mud rotary drilling methods to advance the boring.) 3. Values under "Pocket Penetrometer" are pocket penetrometer resistance readings in tons per square foot, an indication of unconfined compressive strength of cohesive soils.						
95										
100										
105										
110										
115										
120										
125										
130										

Completion Depth: 80.0 ft. Water Depth: See Notes ft., After ____ hrs.

Project No.: 60515039 ft., After ____ hrs.

Project Name: Williams NESE Madison ft., After ____ hrs.

Drilling Method: Hollow Stem Auger + Mud Rotary ft., After ____ hrs.

LOG of BORING No. GB-3

DATE 8/22/2017 SURFACE ELEVATION 39.9 LOCATION Northing: 40.45792 Easting: -74.277532

DEPTH, FT.	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
0	15	SS	Dense to very dense brown to orange brown silty coarse to fine SAND with gravel						
	10	SS	(Fill)	35.9					
5	7	SS	Loose to medium dense brown to brownish gray silty fine SAND			16.2	NP	NP	M
	9	SS							
	10	SS				17.8			
10	9	SS				13.6			
15	7	SS				13.5	NP	NP	M
20	5	SS				8.2			
25	12	SS				23.3			M
30	9	SS		7.9					
35	18	SS	Very stiff to hard gray to dark grayish brown CLAY, trace sand		>4.5	15.1	38	20	M
40	34	SS		-1.6	>4.5				
	19	SS	(Undivided Magothy Unit)						

(Continued on Sheet 2 of 3)

Completion Depth: 78.4 ft. Water Depth: See Notes ft., After ___ hrs.

Project No.: 60515039 ___ ft., After ___ hrs.

Project Name: Williams NESE Madison ___ ft., After ___ hrs.

Drilling Method: Hollow Stem Auger + Mud Rotary ___ ft., After ___ hrs.

AECOM

LOG of BORING No. GB-3

DATE 8/22/2017 SURFACE ELEVATION 39.9 LOCATION Northing: 40.45792 Easting: -74.277532

DEPTH, FT.	SAMPLES	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
45				Medium dense to very dense orange brown to light brown silty fine SAND						
50		36	SS				22.5			M
55		30	SS							
60		24	SS	(Undivided Magothy Unit)	-21.6					
65		50/5"	SS	Very dense orange brown to light brown silty coarse to fine SAND						
70		50/5"	SS							
75		50/5"	SS							
80		50/5"	SS	(Old Bridge Sand)	-38.5					
85				Notes: 1. Ground surface elevation at the boring location was surveyed by Williams surveyors. 2. Groundwater level is inferred to be present at approximately 22 feet below existing ground surface based on examination of split-spoon samples and moisture content lab test results. (Groundwater level could not be observed/measured in the boring due to the use of mud rotary drilling methods to advance the boring.) (Continued on Sheet 3 of 3)						

Completion Depth: 78.4 ft.

Project No.: 60515039

Project Name: Williams NESE Madison

Drilling Method: Hollow Stem Auger + Mud Rotary

Water Depth: See Notes ft., After ___ hrs.

AECOM

LOG of BORING No. GB-3

DATE 8/22/2017 SURFACE ELEVATION 39.9 LOCATION Northing: 40.45792 Easting: -74.277532

DEPTH, FT.	SAMPLES	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
90				3. Values under "Pocket Penetrometer" are pocket penetrometer resistance readings in tons per square foot, an indication of unconfined compressive strength of cohesive soils.						
95										
100										
105										
110										
115										
120										
125										
130										

Completion Depth: 78.4 ft. Water Depth: See Notes ft., After ____ hrs.

Project No.: 60515039 ____ ft., After ____ hrs.

Project Name: Williams NESE Madison ____ ft., After ____ hrs.

Drilling Method: Hollow Stem Auger + Mud Rotary ____ ft., After ____ hrs.

AECOM

LOG of BORING No. GB-4

Sheet 1 of 2

DATE 8/9/2017 SURFACE ELEVATION 46.1 LOCATION Northing: 40.4579 Easting: -74.2773

DEPTH, FT.	SAMPLES	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
0				Asphalt Pavement	45.6					
				Medium dense orange brown to light brown silty coarse to fine SAND with gravel						
5										
		5	SS							
		12	SS				9.7	NP	NP	M
10		24	SS	- very dense						
15		15	SS				10.1			M
20		12	SS				16.0	NP	NP	M
25		15	SS				9.5			M
				(Fill)	18.6					
				Loose to medium dense light brown to orange brown silty fine SAND						
30		13	SS				13.3			M
		11	SS							
35										
		12	SS				24.6			M
40										
				(Undivided Magothy Unit)						
		7	SS	(Continued on Sheet 2 of 2)						

Completion Depth: 78.9 ft.

Project No.: 60515039

Project Name: Williams NESE Madison

Drilling Method: Hollow Stem Auger + Mud Rotary

Water Depth: See Notes ft., After ____ hrs.

AECOM

LOG of BORING No. GB-4

Sheet 2 of 2

DATE 8/9/2017 SURFACE ELEVATION 46.1 LOCATION Northing: 40.4579 Easting: -74.2773

DEPTH, FT.	SAMPLES	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
45				- Continuing medium dense light brown to orange brown silty fine SAND						
50		12	SS							
55		27	SS	(Undivided Magothy Unit)	-10.4					
60		21	SS	Medium dense to very dense orange brown to light brown silty medium to fine SAND						
65		33	SS				19.9			M
70		40	SS							
75		58	SS							
80		50/5"	SS	(Old Bridge Sand)	-32.8					
85				Notes: 1. Ground surface elevation at the boring location was surveyed by Williams surveyors. 2. Groundwater level is inferred to be present at approximately 32 feet below existing ground surface based on examination of split-spoon samples and moisture content lab test results. (Groundwater level could not be observed/measured in the boring due to the use of mud rotary drilling methods to advance the boring.)						

Completion Depth: 78.9 ft. Water Depth: See Notes ft., After ____ hrs.

Project No.: 60515039 ft., After ____ hrs.

Project Name: Williams NESE Madison ft., After ____ hrs.

Drilling Method: Hollow Stem Auger + Mud Rotary ft., After ____ hrs.

LOG of BORING No. GB-5

DATE 9/11/2017 SURFACE ELEVATION 42.3 LOCATION Northing: 40.458 Easting: -74.2772

DEPTH, FT.	SAMPLES	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
0				Asphalt Pavement	41.3					
				Medium dense orange brown to light brown coarse to fine SAND, trace silt and clay	36.3					
5		10	SS	Stiff to very stiff gray silty CLAY, trace sand	35.3	2.8	14.4			
		16	SS	Medium dense orange brown to brown silty coarse to fine SAND, trace gravel			12.0			M
10		12	SS				12.7			M
15		10	SS				13.2	NP	NP	M
20		14	SS		21.3	1.6				
		P	P	Stiff gray silty CLAY, trace sand	17.3					
25		18	SS	Medium dense to dense brown to dark gray silty coarse to fine SAND						
		29	SS				11.9	NP	NP	M
30				(Fill)	10.8					
		9	SS	Medium dense to dense light gray to gray silty medium to fine SAND						
35		10	SS				25.4			M
40		P	P	(Undivided Magothy Unit)						
		39	SS	(Continued on Sheet 2 of 3)						

Completion Depth: 78.9 ft. Water Depth: See Notes ft., After ___ hrs.

Project No.: 60515039 ft., After ___ hrs.

Project Name: Williams NESE Madison ft., After ___ hrs.

Drilling Method: Hollow Stem Auger + Mud Rotary ft., After ___ hrs.

AECOM

LOG of BORING No. GB-5

DATE 9/11/2017 SURFACE ELEVATION 42.3 LOCATION Northing: 40.458 Easting: -74.2772

DEPTH, FT.	SAMPLES	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
45				- Continuing medium dense to dense light gray to gray silty medium to fine SAND						
		12	SS							
50				(Undivided Magothy Unit)	-9.7					
		P	P							
		35	SS	Dense to very dense light gray to orange brown silty medium to fine SAND						
55										
		39	SS				22.2			M
60										
65										
		70	SS							
70										
75										
		50/5"	SS	(Old Bridge Sand)	-36.6					
80				Notes: 1. Ground surface elevation at the boring location was surveyed by Williams surveyors.						
85										

(Continued on Sheet 3 of 3)

Completion Depth: 78.9 ft. Water Depth: See Notes ft., After ___ hrs.

Project No.: 60515039 ft., After ___ hrs.

Project Name: Williams NESE Madison ft., After ___ hrs.

Drilling Method: Hollow Stem Auger + Mud Rotary ft., After ___ hrs.

AECOM

LOG of BORING No. GB-5

DATE 9/11/2017 SURFACE ELEVATION 42.3 LOCATION Northing: 40.458 Easting: -74.2772

DEPTH, FT.	SAMPLES	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
90				2. Groundwater level is inferred to be present at approximately 31 feet below existing ground surface based on examination of split-spoon samples and moisture content lab test results. (Groundwater level could not be observed/measured in the boring due to the use of mud rotary drilling methods to advance the boring.) 3. Values under "Pocket Penetrometer" are pocket penetrometer resistance readings in tons per square foot, an indication of unconfined compressive strength of cohesive soils.						
95										
100										
105										
110										
115										
120										
125										
130										

Completion Depth: 78.9 ft. Water Depth: See Notes ft., After ___ hrs.

Project No.: 60515039 ft., After ___ hrs.

Project Name: Williams NESE Madison ft., After ___ hrs.

Drilling Method: Hollow Stem Auger + Mud Rotary ft., After ___ hrs.

AECOM

LOG of BORING No. GB-7

DATE 8/8/2017 SURFACE ELEVATION 41.4 LOCATION Northing: 40.4583 Easting: -74.2767

DEPTH, FT.	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
0			Asphalt Pavement	40.8					
			Medium dense to very dense orange brown to brownish gray silty coarse to fine SAND with gravel						
5									
	25	SS							
	18	SS				7.9			M
10	22	SS				13.4			
15	15	SS				7.6			
20	16	SS				9.4			M
			(Fill)	18.9					
			Loose to medium dense orange brown to grayish brown silty coarse to fine SAND						
25	8	SS				15.1			M
30	4	SS							
	7	SS				27.0			M
35				4.9					
			Very stiff gray silty CLAY						
	19	SS			3.3				
40				-0.1					
			(Undivided Magothy Unit)						
	13	SS	(Continued on Sheet 2 of 3)						

Completion Depth: 80.0 ft. Water Depth: See Notes ft., After ___ hrs.

Project No.: 60515039 ft., After ___ hrs.

Project Name: Williams NESE Madison ft., After ___ hrs.

Drilling Method: Hollow Stem Auger + Mud Rotary ft., After ___ hrs.

AECOM

LOG of BORING No. GB-7

DATE 8/8/2017 SURFACE ELEVATION 41.4 LOCATION Northing: 40.4583 Easting: -74.2767

DEPTH, FT.	SAMPLES	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
45				Medium dense to very dense gray to orange brown silty medium to fine SAND						
50		20	SS							
55		35	SS				19.1			M
60		40	SS							
65		28	SS	(Undivided Magothy Unit)	-25.1					
70		50/5"	SS	Very dense gray to orange brown silty medium to fine SAND						
75		50/5"	SS							
80		59	SS	(Old Bridge Sand)	-38.6					
85				Notes: 1. Ground surface elevation at the boring location was surveyed by Williams surveyors.						

(Continued on Sheet 3 of 3)

Completion Depth: 80.0 ft.
Project No.: 60515039
Project Name: Williams NESE Madison
Drilling Method: Hollow Stem Auger + Mud Rotary

Water Depth: See Notes ft., After ___ hrs.

LOG of BORING No. GB-7

Sheet 3 of 3

DATE 8/8/2017 SURFACE ELEVATION 41.4 LOCATION Northing: 40.4583 Easting: -74.2767

DEPTH, FT.	SAMPLES	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
90				2. Groundwater level is inferred to be present at approximately 27 feet below existing ground surface based on examination of split-spoon samples and moisture content lab test results. (Groundwater level could not be observed/measured in the boring due to the use of mud rotary drilling methods to advance the boring.) 3. Values under "Pocket Penetrometer" are pocket penetrometer resistance readings in tons per square foot, an indication of unconfined compressive strength of cohesive soils.						
95										
100										
105										
110										
115										
120										
125										
130										

Completion Depth: 80.0 ft. Water Depth: See Notes ft., After ___ hrs.

Project No.: 60515039 ft., After ___ hrs.

Project Name: Williams NESE Madison ft., After ___ hrs.

Drilling Method: Hollow Stem Auger + Mud Rotary ft., After ___ hrs.

AECOM

Project: Williams GSP Crossing
Project No.: 60515039

SUMMARY OF LABORATORY TEST RESULTS

Boring and Sample Number	Depth (feet)	Classification	USCS Symbol	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Specific Gravity	Organic Content (%)	Grain Size: <#200 (%)	Grain Size: <2µ (%)	Compaction	Consolidation	Unconfined Compression: Stress (psi)	Unconfined Compression: Strain (%)	Triaxial Compression: UU	Triaxial Compression: CIU	Permeability (cm/sec)	Special Tests
GB-2 S-3	4.0-6.0			9.8															
GB-2 S-5	8.0-10.0	Light brown POORLY GRADED SAND with SILT	SP-SM	8.3						12									
GB-2 S-7	14.0-16.0	Light brown POORLY GRADED SAND with SILT	SP-SM	26.5						5									
GB-2 S-8	19.0-21.0	Brown SILTY SAND	SM	28.9		NP	NP			48									
GB-2 S-10	29.0-31.0	Brown SILTY SAND with GRAVEL	SM	16.4		NP	NP			36									
GB-2 S-11	33.0-35.0	Gray POORLY GRADED SAND with SILT	SP-SM	24.6						9									
GB-2 S-14	48.0-50.0	Light brown POORLY GRADED SAND with SILT	SP-SM	24.4						8									
GB-3 S-3	4.0-6.0	Brown SILTY SAND	SM	16.2		NP	NP			30									
GB-3 S-5	8.0-10.0			17.8															
GB-3 S-6	10.0-12.0			13.6															
GB-3 S-7	14.0-16.0	Brown SILTY SAND	SM	13.5		NP	NP			24									
GB-3 S-8	19.0-21.0			8.2															
GB-3 S-9	24.0-26.0	Brown SILTY SAND	SM	23.3						12									
GB-3 S-11	33.0-35.0	Gray LEAN CLAY	CL	15.1		38	20			90									
GB-3 S-14	48.0-50.0	Gray SILTY SAND	SM	22.5						29									
GB-4 S-2	8.0-10.0	Brown SILTY SAND	SM	9.7		NP	NP			26									
GB-4 S-4	14.0-16.0	Brown SILTY SAND	SM	10.1						21									
GB-4 S-5	19.0-21.0	Brown SILTY SAND	SM	16.0		NP	NP			29									
GB-4 S-6	24.0-26.0	Brown SILTY SAND with GRAVEL	SM	9.5						15									

Note: The soil classification is based partially on visual classification unless both grain size and Atterberg limits are performed.

* Refer to Laboratory Test Curves

Project File Path:

Project: Williams GSP Crossing
Project No.: 60515039

AECOM

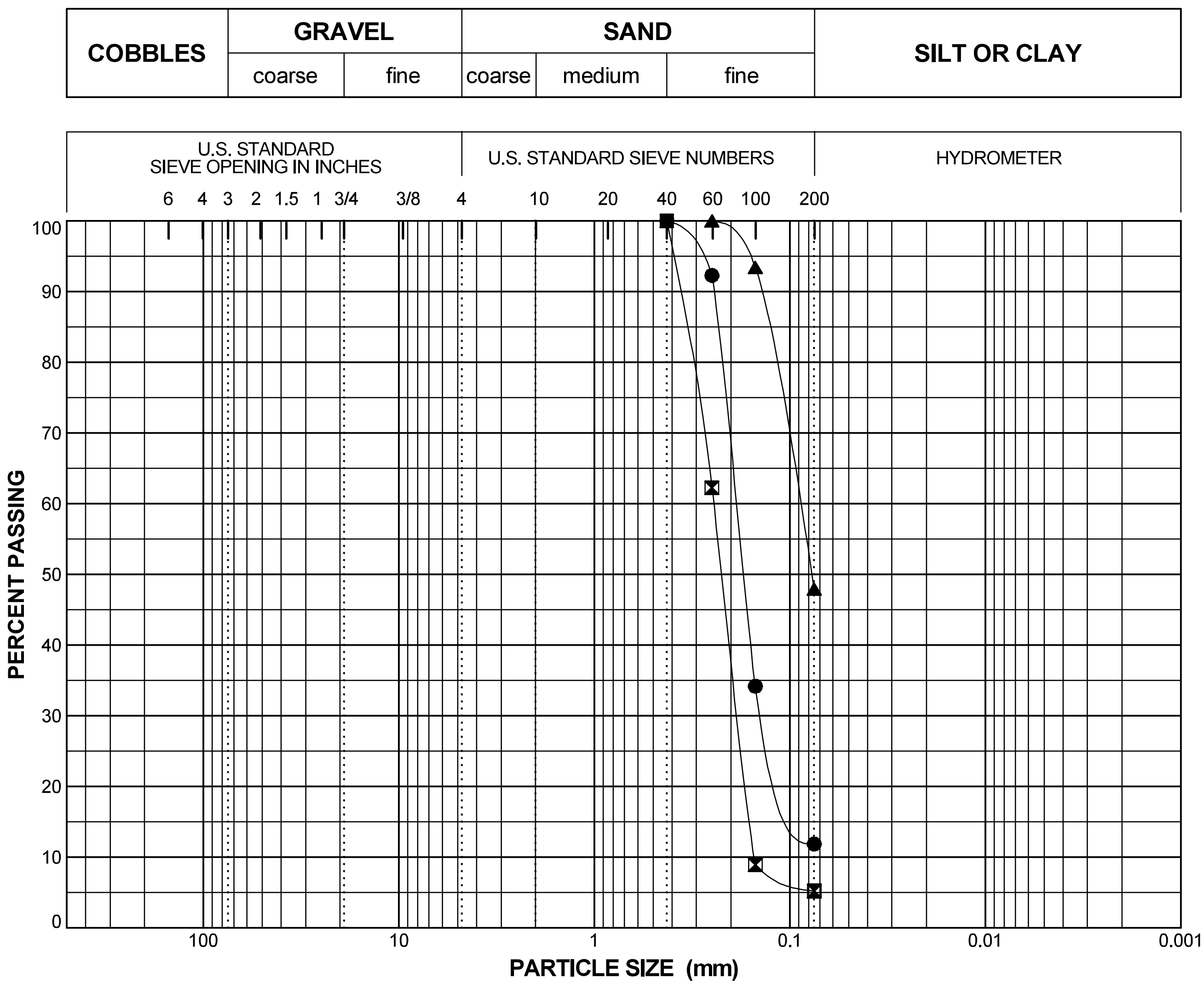
SUMMARY OF LABORATORY TEST RESULTS

Boring and Sample Number	Depth (feet)	Classification	USCS Symbol	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits		Specific Gravity	Organic Content (%)	Grain Size		Compaction	Consolidation	Unconfined Compression		Triaxial Compression		Permeability (cm/sec)	Special Tests
						Liquid Limit	Plastic Limit			<#200 (%)	<2µ (%)			Stress (psi)	Strain (%)	UU	CIU		
GB-4 S-7	29.0-31.0	Light brown SILTY SAND	SM	13.3						22									
GB-4 S-9	38.0-40.0	Light brown SILTY SAND	SM	24.6						18									
GB-4 S-14	63.0-65.0	Brown SILTY SAND	SM	19.9						36									
GB-5 S-4	6.0-8.0			14.4															
GB-5 S-5	8.0-10.0	Brown SILTY SAND	SM	12.0						22									
GB-5 S-6	10.0-12.0	Brown SILTY SAND	SM	12.7						26									
GB-5 S-7	15.0-17.0	Brown SILTY SAND	SM	13.2		NP	NP			18									
GB-5 S-11	28.0-30.0	Brown SILTY SAND	SM	11.9		NP	NP			20									
GB-5 S-13	38.0-40.0	Brown SILTY SAND	SM	25.4						15									
GB-5 S-19	58.0-60.0	Gray SILTY SAND	SM	22.2						30									
GB-7 S-2	8.0-10.0	Brown SILTY SAND with GRAVEL	SM	7.9						24									
GB-7 S-3	10.0-12.0			13.4															
GB-7 S-4	14.0-16.0			7.6															
GB-7 S-5	19.0-21.0	Brown SILTY SAND with GRAVEL	SM	9.4						22									
GB-7 S-6	24.0-26.0	Brown SILTY SAND	SM	15.1						18									
GB-7 S-7	33.0-35.0	Brown SILTY SAND	SM	27.0						12									
GB-7 S-12	53.0-55.0	Gray brown SILTY SAND	SM	19.1						14									

Note: The soil classification is based partially on visual classification unless both grain size and Atterberg limits are performed.

* Refer to Laboratory Test Curves

Project File Path:



SYMBOL	●	⊠	▲
Boring	GB-2	GB-2	GB-2
Sample	S-5	S-7	S-8
Spec			
Depth (ft)	8.0-10.0	14.0-16.0	19.0-21.0
% +3"	0.0	0.0	0.0
% Gravel	0.0	0.0	0.0
% Sand	88.1	94.8	52.1
% Fines	11.9	5.2	47.9
% -2μ			
Cc	1.30	0.91	
Cu	2.66	1.61	
LL			NP
PL			NP
PI			NP
USCS	SP-SM	SP-SM	SM
w (%)	8.3	26.5	28.9

Particle Size (Sieve #)	PERCENT FINER ●	⊠	▲
2"			
1 1/2"			
1"			
3/4"			
1/2"			
3/8"			
4			
10			
20			
40	100.0	100.0	
60	92.3	62.2	100.0
100	34.2	8.9	93.4
200	11.9	5.2	47.9

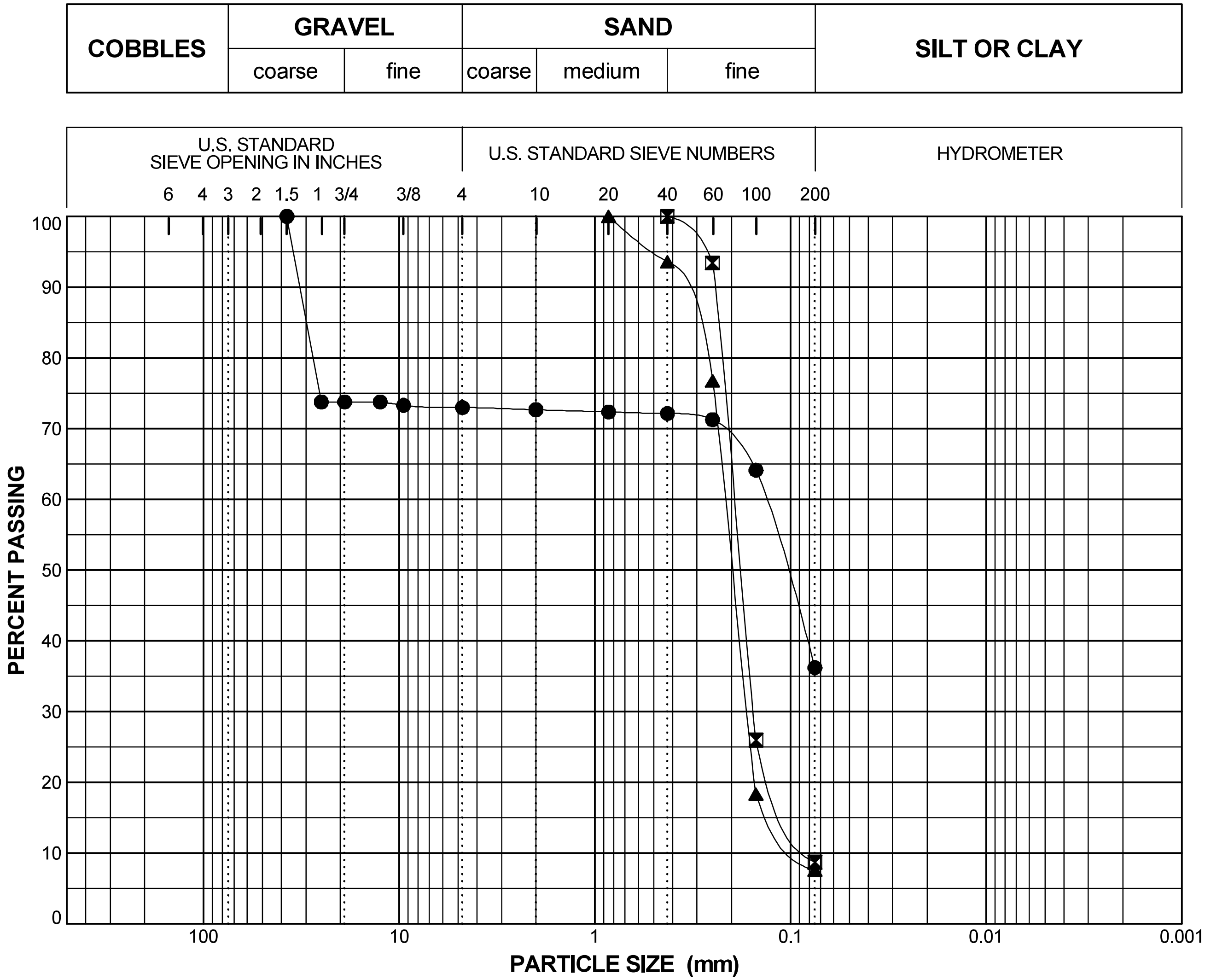
SYMBOL	DESCRIPTION AND REMARKS
●	Light brown POORLY GRADED SAND with SILT (SP-SM)
⊠	Light brown POORLY GRADED SAND with SILT (SP-SM)
▲	Brown SILTY SAND (SM)

PARTICLE SIZE DISTRIBUTION

Williams GSP Crossing

Project Number 60515039 | October 2017 | Figure B-1

AECOM



SYMBOL	●	⊠	▲
Boring	GB-2	GB-2	GB-2
Sample	S-10	S-11	S-14
Spec			
Depth (ft)	29.0-31.0	33.0-35.0	48.0-50.0
% +3"	0.0	0.0	0.0
% Gravel	27.0	0.0	0.0
% Sand	36.8	91.3	92.4
% Fines	36.2	8.7	7.6
% -2μ			
Cc		1.56	1.46
Cu		2.46	2.46
LL	NP		
PL	NP		
PI	NP		
USCS	SM	SP-SM	SP-SM
w (%)	16.4	24.6	24.4

Particle Size (Sieve #)	PERCENT FINER ●	⊠	▲
2"			
1 1/2"	100.0		
1"	73.8		
3/4"	73.8		
1/2"	73.8		
3/8"	73.3		
4	73.0		
10	72.7		
20	72.4		100.0
40	72.1	100.0	93.6
60	71.3	93.4	76.8
100	64.1	25.9	18.3
200	36.2	8.7	7.6

SYMBOL	DESCRIPTION AND REMARKS
●	Brown SILTY SAND with GRAVEL (SM)
⊠	Gray POORLY GRADED SAND with SILT (SP-SM)
▲	Light brown POORLY GRADED SAND with SILT (SP-SM)

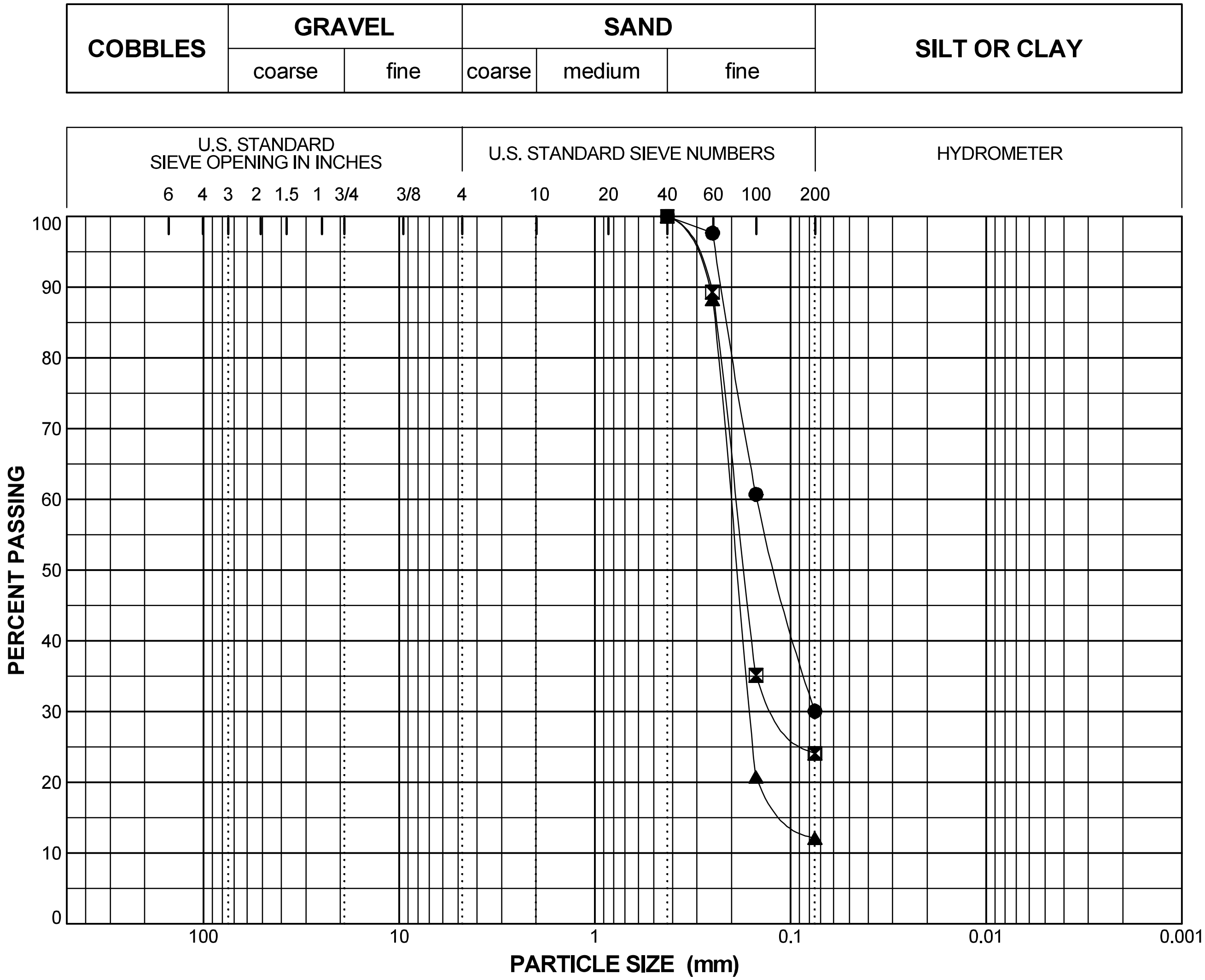
PARTICLE SIZE DISTRIBUTION

Williams GSP Crossing

Project Number 60515039	October 2017	Figure B-2

AECOM

SIEVE_BLUEBELL_NEW LAB_WILLIAMAS GSP CROSSING.GPJ URS_BLUE.GDT 10/10/17



SYMBOL	●	⊠	▲
Boring	GB-3	GB-3	GB-3
Sample	S-3	S-7	S-9
Spec			
Depth (ft)	4.0-6.0	14.0-16.0	24.0-26.0
% +3"	0.0	0.0	0.0
% Gravel	0.0	0.0	0.0
% Sand	70.0	75.9	87.9
% Fines	30.0	24.1	12.1
% -2μ			
Cc			2.02
Cu			3.17
LL	NP	NP	
PL	NP	NP	
PI	NP	NP	
USCS	SM	SM	SM
w (%)	16.2	13.5	23.3

Particle Size (Sieve #)	PERCENT FINER ●	⊠	▲
2"			
1 1/2"			
1"			
3/4"			
1/2"			
3/8"			
4			
10			
20			
40	100.0	100.0	100.0
60	97.6	89.3	88.3
100	60.7	35.1	20.8
200	30.0	24.1	12.1

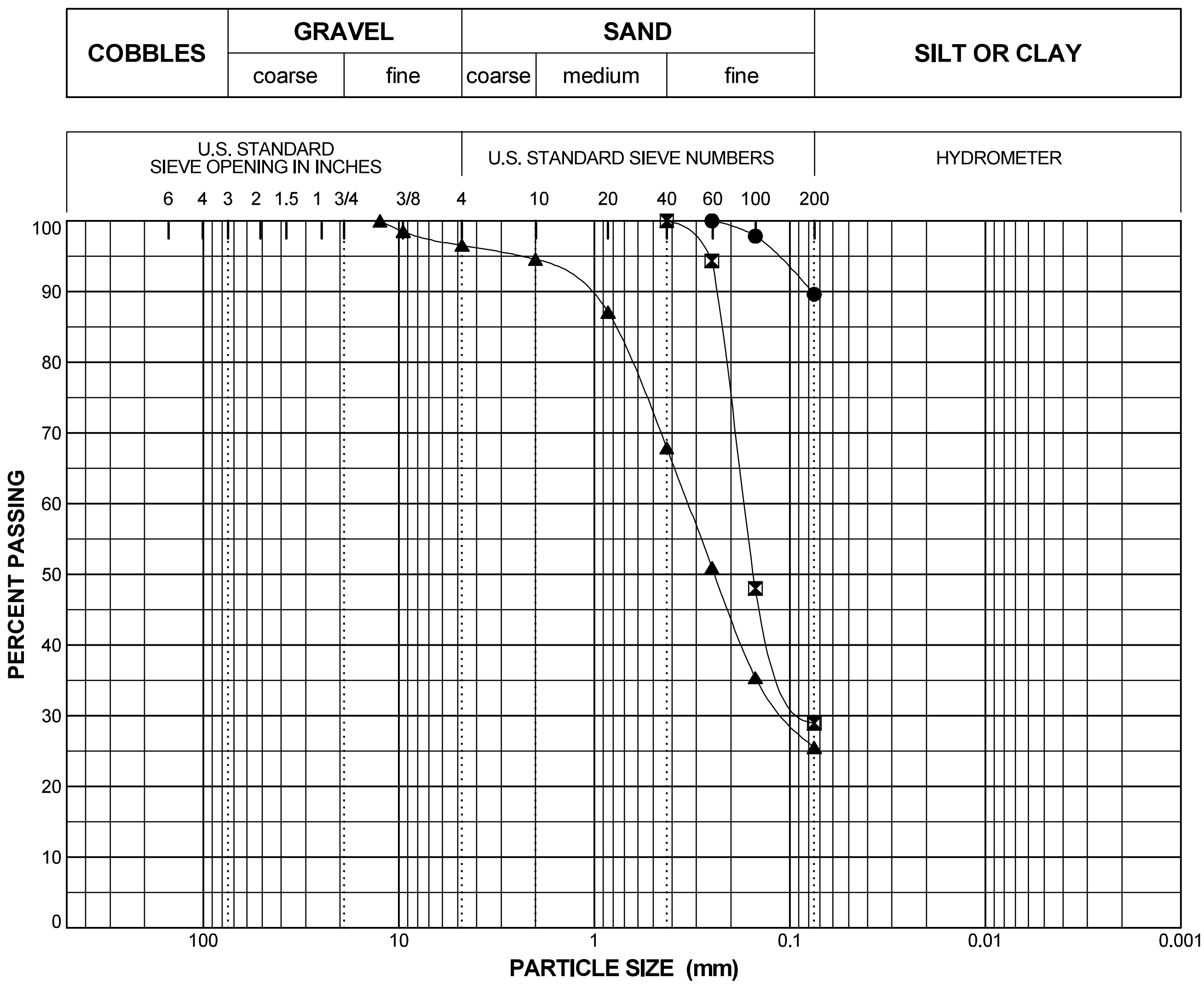
SYMBOL	DESCRIPTION AND REMARKS
●	Brown SILTY SAND (SM)
⊠	Brown SILTY SAND (SM)
▲	Brown SILTY SAND (SM)

PARTICLE SIZE DISTRIBUTION

Williams GSP Crossing

Project Number 60515039	October 2017	Figure B-3

AECOM



SYMBOL	DESCRIPTION AND REMARKS
●	Gray LEAN CLAY (CL)
⊠	Gray SILTY SAND (SM)
▲	Brown SILTY SAND (SM)

SYMBOL	●	⊠	▲
Boring	GB-3	GB-3	GB-4
Sample	S-11	S-14	S-2
Spec			
Depth (ft)	33.0-35.0	48.0-50.0	8.0-10.0
% +3"	0.0	0.0	0.0
% Gravel	0.0	0.0	3.5
% Sand	10.4	71.1	71.0
% Fines	89.6	28.9	25.5
% -2μ			
Cc			
Cu			
LL	38		NP
PL	20		NP
PI	18		NP
USCS	CL	SM	SM
w (%)	15.1	22.5	9.7

Particle Size (Sieve #)	PERCENT FINER ●	PERCENT FINER ⊠	PERCENT FINER ▲
2"			
1 1/2"			
1"			
3/4"			
1/2"			100.0
3/8"			98.5
4			96.5
10			94.6
20			87.1
40		100.0	67.9
60	100.0	94.3	50.9
100	97.8	48.0	35.4
200	89.6	28.9	25.5

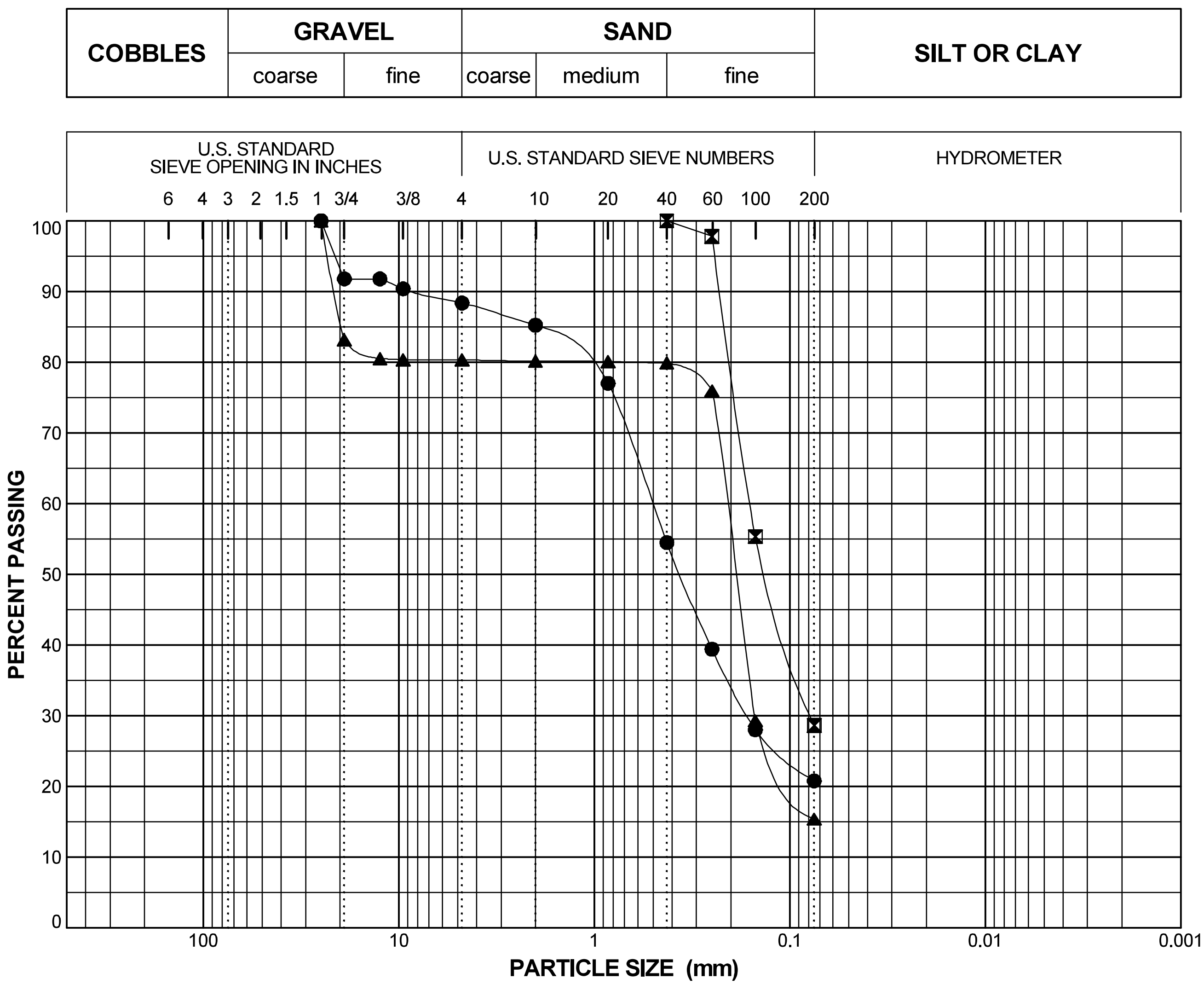
PARTICLE SIZE DISTRIBUTION

Williams GSP Crossing

Project Number 60515039	October 2017	Figure B-4

AECOM

SIEVE_BLUEBELL_NEW LAB_WILLIAMAS GSP CROSSING.GPJ URS_BLUE.GDT 10/10/17



SYMBOL	●	⊠	▲
Boring	GB-4	GB-4	GB-4
Sample	S-4	S-5	S-6
Spec			
Depth (ft)	14.0-16.0	19.0-21.0	24.0-26.0
% +3"	0.0	0.0	0.0
% Gravel	11.6	0.0	19.7
% Sand	67.6	71.4	64.9
% Fines	20.8	28.6	15.4
% -2μ			
Cc			
Cu			
LL		NP	
PL		NP	
PI		NP	
USCS	SM	SM	SM
w (%)	10.1	16.0	9.5

Particle Size (Sieve #)	PERCENT FINER ●	⊠	▲
2"			
1 1/2"			
1"	100.0		100.0
3/4"	91.8		83.2
1/2"	91.8		80.5
3/8"	90.4		80.3
4	88.4		80.3
10	85.2		80.2
20	77.0		80.1
40	54.5	100.0	79.9
60	39.4	97.8	76.0
100	28.0	55.3	29.3
200	20.8	28.6	15.4

SYMBOL	DESCRIPTION AND REMARKS
●	Brown SILTY SAND (SM)
⊠	Brown SILTY SAND (SM)
▲	Brown SILTY SAND with GRAVEL (SM)

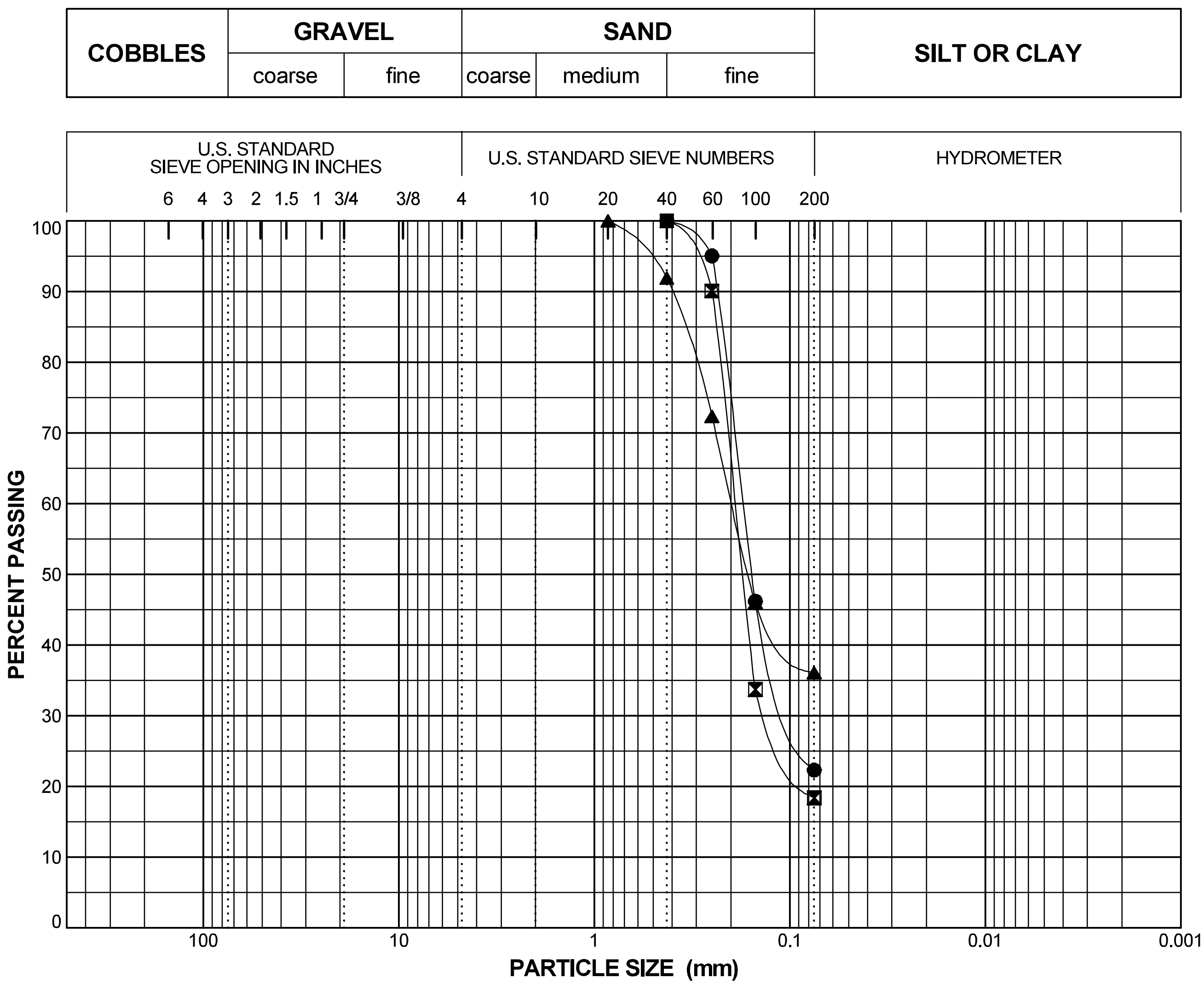
PARTICLE SIZE DISTRIBUTION

Williams GSP Crossing

Project Number 60515039	October 2017	Figure B-5

AECOM

SIEVE_BLUEBELL_NEW LAB_WILLIAMAS GSP CROSSING.GPJ URS_BLUE.GDT 10/10/17



SYMBOL	●	⊠	▲
Boring	GB-4	GB-4	GB-4
Sample	S-7	S-9	S-14
Spec			
Depth (ft)	29.0-31.0	38.0-40.0	63.0-65.0
% +3"	0.0	0.0	0.0
% Gravel	0.0	0.0	0.0
% Sand	77.7	81.6	63.9
% Fines	22.3	18.4	36.1
% -2μ			
Cc			
Cu			
LL			
PL			
PI			
USCS	SM	SM	SM
w (%)	13.3	24.6	19.9

Particle Size (Sieve #)	PERCENT FINER ●	⊠	▲
2"			
1 1/2"			
1"			
3/4"			
1/2"			
3/8"			
4			
10			
20			100.0
40	100.0	100.0	91.9
60	95.0	90.1	72.3
100	46.2	33.7	46.0
200	22.3	18.4	36.1

SYMBOL	DESCRIPTION AND REMARKS
●	Light brown SILTY SAND (SM)
⊠	Light brown SILTY SAND (SM)
▲	Brown SILTY SAND (SM)

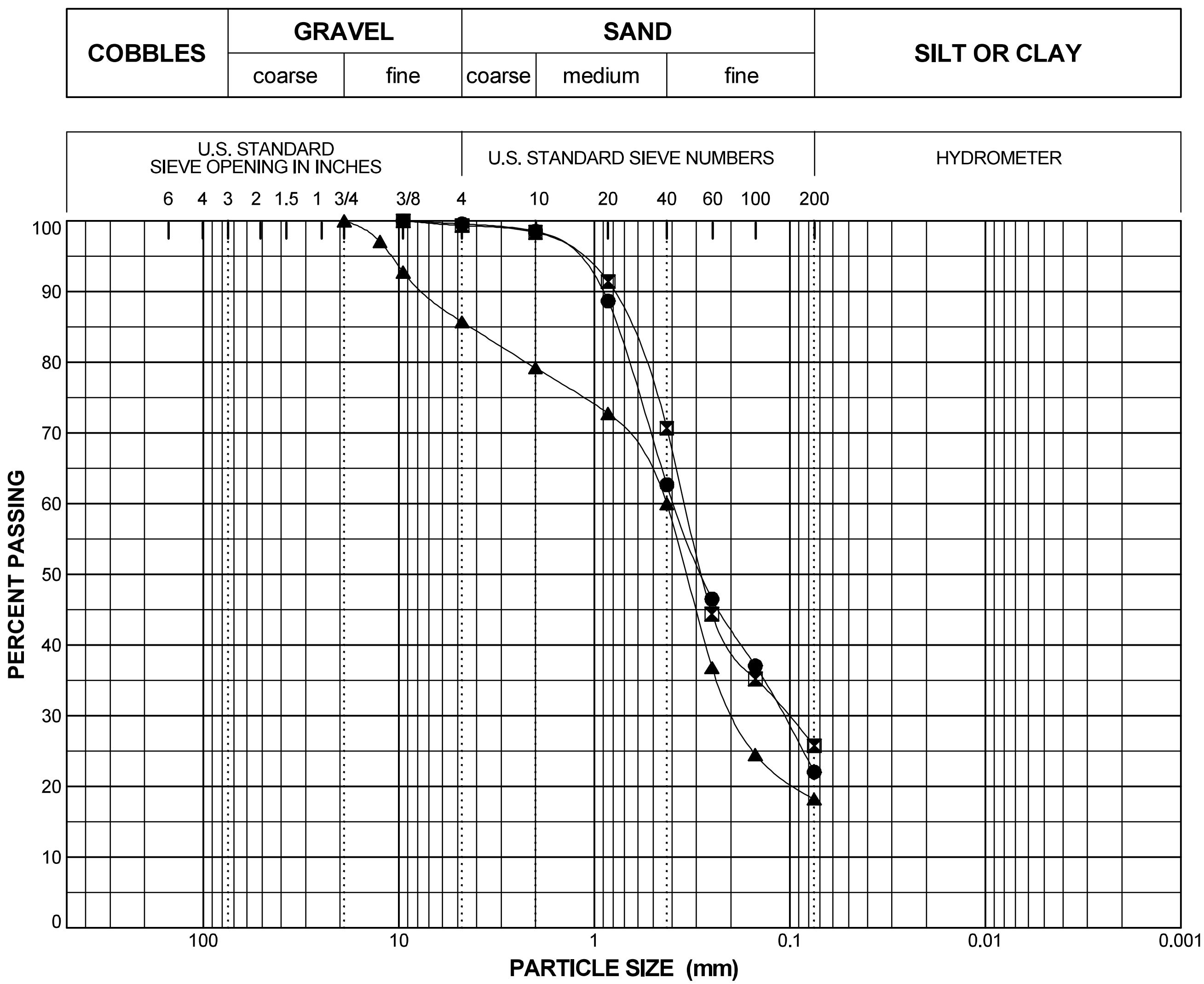
PARTICLE SIZE DISTRIBUTION

Williams GSP Crossing

Project Number 60515039	October 2017	Figure B-6

AECOM

SIEVE_BLUEBELL_NEW LAB_WILLIAMAS GSP CROSSING.GPJ URS_BLUE.GDT 10/10/17



SYMBOL	●	☒	▲
Boring	GB-5	GB-5	GB-5
Sample	S-5	S-6	S-7
Spec			
Depth (ft)	8.0-10.0	10.0-12.0	15.0-17.0
% +3"	0.0	0.0	0.0
% Gravel	0.4	0.7	14.3
% Sand	77.5	73.6	67.5
% Fines	22.0	25.7	18.2
% -2μ			
Cc			
Cu			
LL			NP
PL			NP
PI			NP
USCS	SM	SM	SM
w (%)	12.0	12.7	13.2

Particle Size (Sieve #)	PERCENT FINER ●	☒	▲
2"			
1 1/2"			
1"			
3/4"			100.0
1/2"			97.1
3/8"	100.0	100.0	92.8
4	99.6	99.3	85.7
10	98.5	98.4	79.2
20	88.7	91.4	72.8
40	62.7	70.7	60.0
60	46.5	44.4	36.8
100	37.1	35.2	24.5
200	22.0	25.7	18.2

SYMBOL	DESCRIPTION AND REMARKS
●	Brown SILTY SAND (SM)
☒	Brown SILTY SAND (SM)
▲	Brown SILTY SAND (SM)

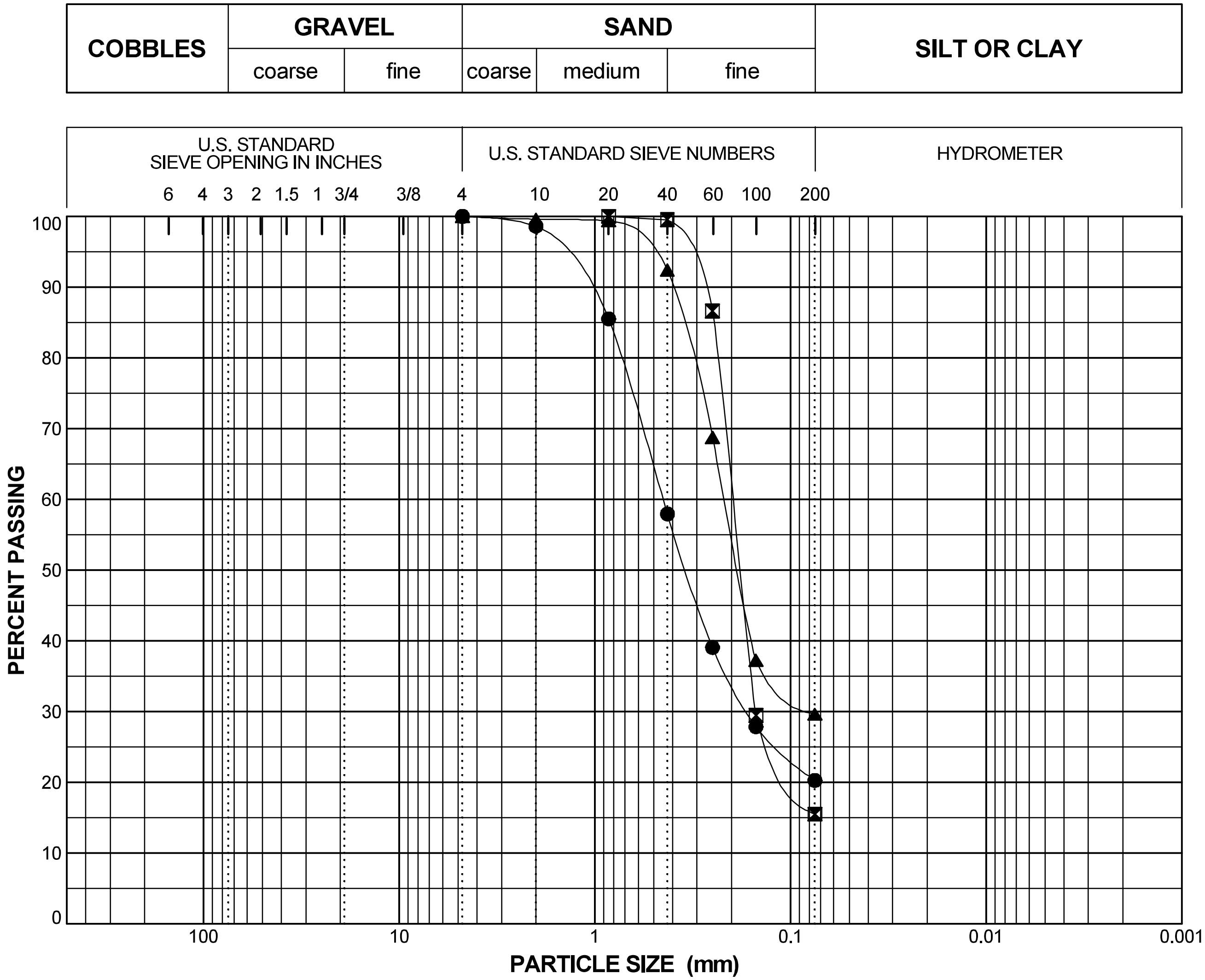
PARTICLE SIZE DISTRIBUTION

Williams GSP Crossing

Project Number 60515039	October 2017	Figure B-7

AECOM

SIEVE_BLUEBELL_NEW LAB_WILLIAMAS GSP CROSSING.GPJ URS_BLUE.GDT 10/10/17



SYMBOL	●	⊠	▲
Boring	GB-5	GB-5	GB-5
Sample	S-11	S-13	S-19
Spec			
Depth (ft)	28.0-30.0	38.0-40.0	58.0-60.0
% +3"	0.0	0.0	0.0
% Gravel	0.0	0.0	0.0
% Sand	79.7	84.5	70.4
% Fines	20.3	15.5	29.6
% -2μ			
Cc			
Cu			
LL	NP		
PL	NP		
PI	NP		
USCS	SM	SM	SM
w (%)	11.9	25.4	22.2

Particle Size (Sieve #)	PERCENT FINER ●	⊠	▲
2"			
1 1/2"			
1"			
3/4"			
1/2"			
3/8"			
4	100.0		100.0
10	98.6		99.6
20	85.5	100.0	99.4
40	57.9	99.5	92.4
60	39.1	86.6	68.8
100	27.8	29.4	37.2
200	20.3	15.5	29.6

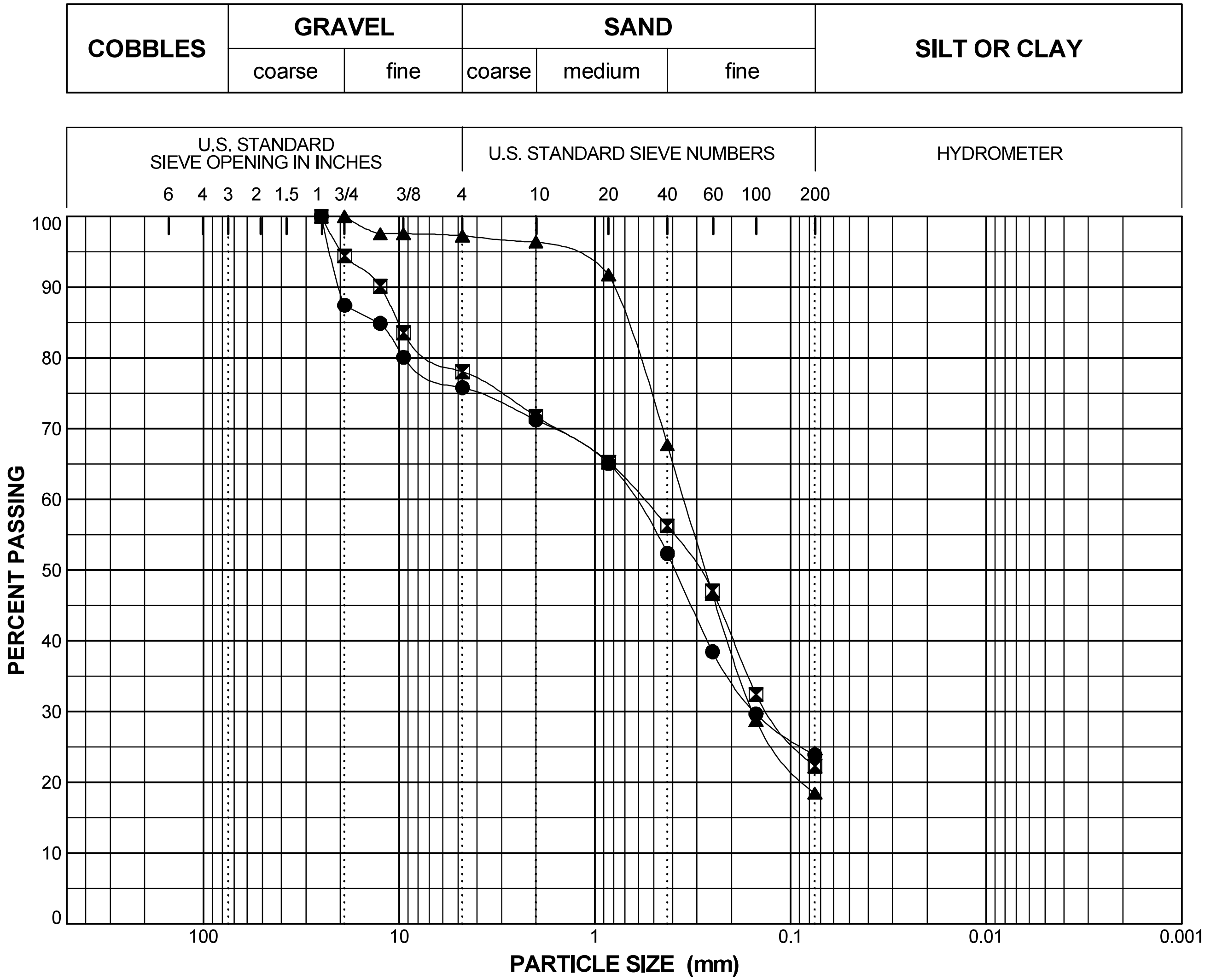
SYMBOL	DESCRIPTION AND REMARKS
●	Brown SILTY SAND (SM)
⊠	Brown SILTY SAND (SM)
▲	Gray SILTY SAND (SM)

PARTICLE SIZE DISTRIBUTION

Williams GSP Crossing

Project Number 60515039	October 2017	Figure B-8

AECOM



SYMBOL	●	⊠	▲
Boring	GB-7	GB-7	GB-7
Sample	S-2	S-5	S-6
Spec			
Depth (ft)	8.0-10.0	19.0-21.0	24.0-26.0
% +3"	0.0	0.0	0.0
% Gravel	24.2	21.9	2.7
% Sand	51.9	55.8	78.8
% Fines	23.9	22.3	18.5
% -2μ			
Cc			
Cu			
LL			
PL			
PI			
USCS	SM	SM	SM
w (%)	7.9	9.4	15.1

Particle Size (Sieve #)	PERCENT FINER ●	⊠	▲
2"			
1 1/2"			
1"	100.0	100.0	
3/4"	87.4	94.4	100.0
1/2"	84.9	90.1	97.5
3/8"	80.1	83.5	97.5
4	75.8	78.1	97.3
10	71.2	71.7	96.4
20	65.1	65.3	91.8
40	52.3	56.2	67.7
60	38.5	47.0	46.5
100	29.7	32.4	28.8
200	23.9	22.3	18.5

SYMBOL	DESCRIPTION AND REMARKS
●	Brown SILTY SAND with GRAVEL (SM)
⊠	Brown SILTY SAND with GRAVEL (SM)
▲	Brown SILTY SAND (SM)

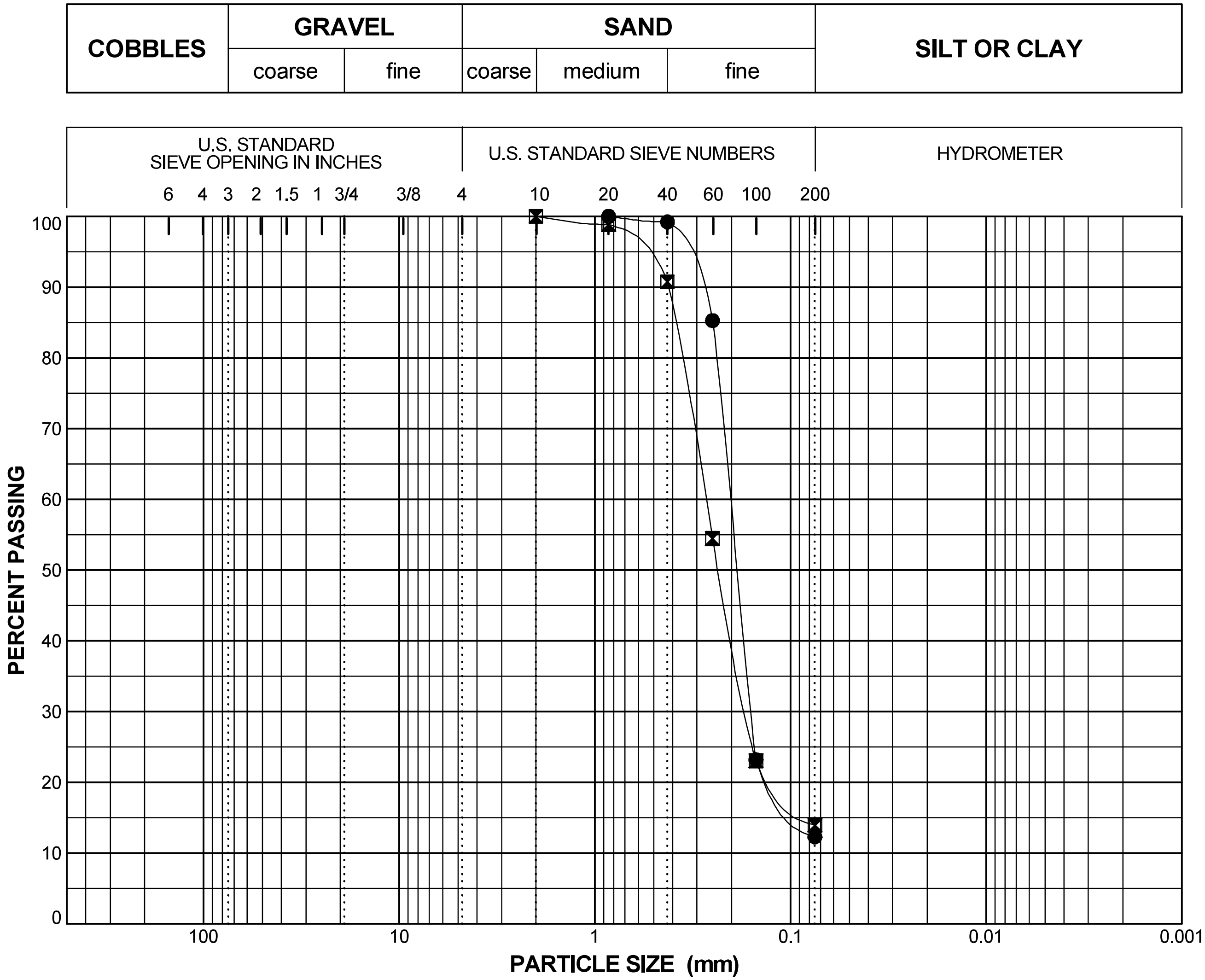
PARTICLE SIZE DISTRIBUTION

Williams GSP Crossing

Project Number 60515039	October 2017	Figure B-9

AECOM

SIEVE_BLUEBELL_NEW LAB_WILLIAMAS GSP CROSSING.GPJ URS_BLUE.GDT 10/10/17



SYMBOL	●	⊠
Boring	GB-7	GB-7
Sample	S-7	S-12
Spec		
Depth (ft)	33.0-35.0	53.0-55.0
% +3"	0.0	0.0
% Gravel	0.0	0.0
% Sand	87.7	86.1
% Fines	12.3	13.9
% -2μ		
Cc	1.91	
Cu	3.13	
LL		
PL		
PI		
USCS	SM	SM
w (%)	27.0	19.1

Particle Size (Sieve #)	PERCENT FINER ●	PERCENT FINER ⊠
2"		
1 1/2"		
1"		
3/4"		
1/2"		
3/8"		
4		
10		100.0
20	100.0	98.9
40	99.2	90.8
60	85.3	54.4
100	23.2	23.0
200	12.3	13.9

SYMBOL	DESCRIPTION AND REMARKS
●	Brown SILTY SAND (SM)
⊠	Gray brown SILTY SAND (SM)

PARTICLE SIZE DISTRIBUTION

Williams GSP Crossing

Project Number 60515039	October 2017	Figure B-10

AECOM

SIEVE_BLUEBELL_NEW LAB_WILLIAMAS GSP CROSSING.GPJ URS_BLUE.GDT 10/10/17

Appendix B

Dewatering Calculation Details

Qal (H=10)

Feature ID | **Trench Segment (100-ft)**

D_{trench}	7.0	ft	Ground EL	100	ft msl
L_{trench}	100	ft	GW EL	99	ft msl
			Add-on (Max. GW EL)	0.0	ft
			Trench Bottom	93	ft msl

1. Calculation of radius of influence

Eq. 1 - Radius of influence

$$R = C\ (\Delta h)\sqrt{k}$$

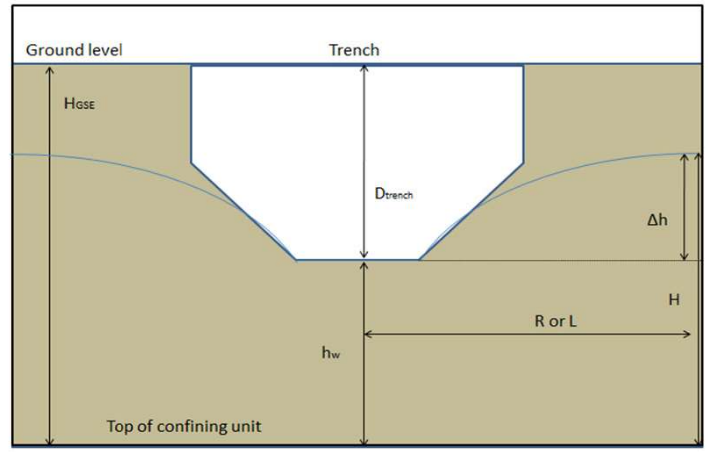
Δh (always ≥ 0)	6	ft			
C	3	-/-		4.0	ft/day
k	1.4E+01	µm/sec	k (Qal)	1.4E-03	cm/sec
R, wit safety factor	34	ft	Safety Factor for R	0.5	

2. Calculation of estimated dewatering

Eq.2 - Required dewatering

$$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$$

H	10	ft
h_w	4	ft
k	4.6E-05	ft/sec
L	34	ft
Q	0.00010	cf/sec/ft
Q_{trench}	4.6	gpm



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft *(If trench bottom is below confining unit, then h_w = 0)*
Δh	H - h_w
R	Radius of influence, ft. R = L *(If trench bottom is above the static gw level, then R = 0, and Q = 0)*
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

Feature ID — **Trench Segment (100-ft)**

D_{trench}	7.0	ft	Ground EL	100	ft msl
L_{trench}	100	ft	GW EL	99	ft msl
			Add-on (Max. GW EL)	0.0	ft
			Trench Bottom	93	ft msl

1. Calculation of radius of influence

Eq. 1 - Radius of influence

$$R = C\ (\Delta h)\sqrt{k}$$

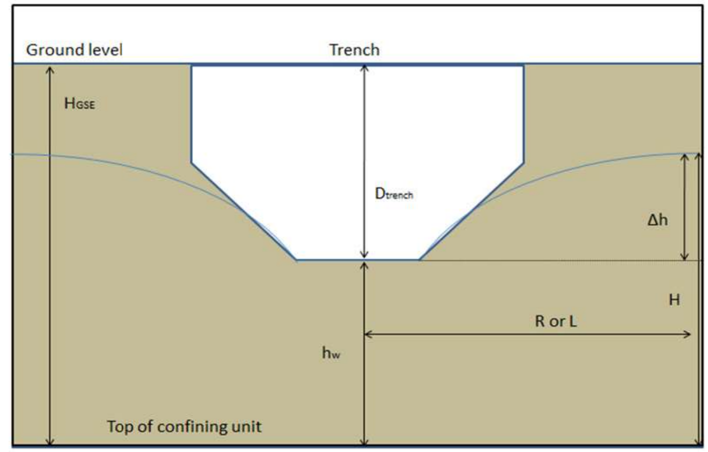
Δh (always ≥ 0)	6	ft			
C	3	-/-		4.0	ft/day
k	1.4E+01	μm/sec	k (Qal)	1.4E-03	cm/sec
R, wit safety factor	34	ft	Safety Factor for R	0.5	

2. Calculation of estimated dewatering

Eq.2 - Required dewatering

$$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$$

H	25	ft
h_w	19	ft
k	4.6E-05	ft/sec
L	34	ft
Q	0.00029	cf/sec/ft
Q_{trench}	12.8	gpm



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft *(If trench bottom is below confining unit, then h_w = 0)*
Δh	H - h_w
R	Radius of influence, ft. R = L *(If trench bottom is above the static gw level, then R = 0, and Q = 0)*
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

AECOM

Qal (H=50)

Feature ID — **Trench Segment (100-ft)**

D_{trench}	7.0	ft	Ground EL	100	ft msl
L_{trench}	100	ft	GW EL	99	ft msl
			Add-on (Max. GW EL)	0.0	ft
			Trench Bottom	93	ft msl

1. Calculation of radius of influence

Eq. 1 - Radius of influence

$$R = C\ (\Delta h)\sqrt{k}$$

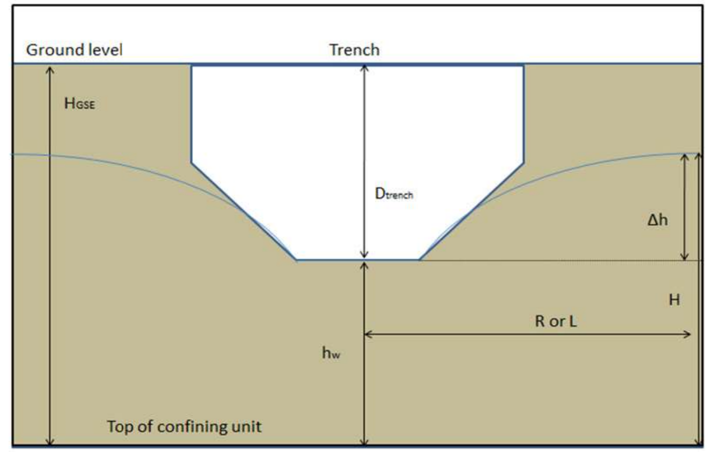
Δh (always ≥ 0)	6	ft			
C	3	-/-		4.0	ft/day
k	1.4E+01	µm/sec	k (Qal)	1.4E-03	cm/sec
R, wit safety factor	34	ft	Safety Factor for R	0.5	

2. Calculation of estimated dewatering

Eq.2 - Required dewatering

$$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$$

H	50	ft
h_w	44	ft
k	4.6E-05	ft/sec
L	34	ft
Q	0.00059	cf/sec/ft
Q_{trench}	26.3	gpm



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft *(If trench bottom is below confining unit, then h_w = 0)*
Δh	H - h_w
R	Radius of influence, ft. R = L *(If trench bottom is above the static gw level, then R = 0, and Q = 0)*
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

Mag (H=10)

Feature ID — **Trench Segment (100-ft)**

D_{trench}	7.0	ft	Ground EL	100	ft msl
L_{trench}	100	ft	GW EL	99	ft msl
			Add-on (Max. GW EL)	0.0	ft
			Trench Bottom	93	ft msl

1. Calculation of radius of influence

Eq. 1 - Radius of influence

$$R = C\,(\Delta h)\sqrt{k}$$

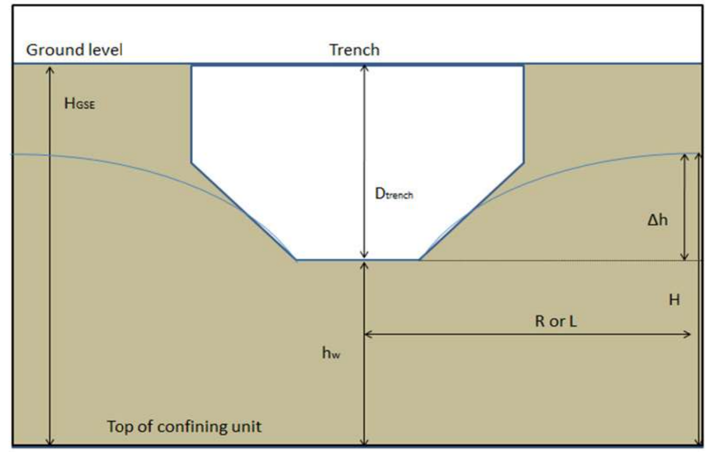
Δh (always ≥ 0)	6	ft			
C	3	-/-		3.2	ft/day
k	1.1E+01	µm/sec	k (Magothy, K)	1.1E-03	cm/sec
R, wit safety factor	30	ft	Safety Factor for R	0.5	

2. Calculation of estimated dewatering

Eq.2 - Required dewatering

$$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$$

H	10	ft
h_w	4	ft
k	3.7E-05	ft/sec
L	30	ft
Q	0.00009	cf/sec/ft
Q_{trench}	4.1	gpm



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft
	(If trench bottom is below confining unit, then h_w = 0)
Δh	H - h_w
R	Radius of influence, ft. R = L
	(If trench bottom is above the static gw level, then R = 0, and Q = 0)
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

Mag (H=25)

Feature ID	Trench Segment (100-ft)				
D_{trench}	7.0	ft	Ground EL	100	ft msl
L_{trench}	100	ft	GW EL	99	ft msl
			Add-on (Max. GW EL)	0.0	ft
			Trench Bottom	93	ft msl

1. Calculation of radius of influence

Eq. 1 - Radius of influence

$$R = C\ (\Delta h)\sqrt{k}$$

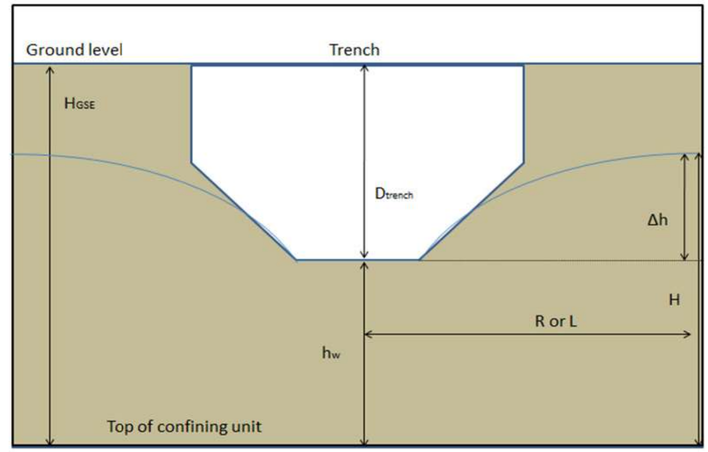
Δh (always $\geq$ 0)	6	ft			
C	3	-/-		3.2	ft/day
k	1.1E+01	µm/sec	k (Magothy, K)	1.1E-03	cm/sec
R, wit safety factor	30	ft	Safety Factor for R	0.5	Enter!

2. Calculation of estimated dewatering

Eq.2 - Required dewatering

$$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$$

H	25	ft
h_w	19	ft
k	3.7E-05	ft/sec
L	30	ft
Q	0.00026	cf/sec/ft
Q_{trench}	11.5	gpm



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft
	(If trench bottom is below confining unit, then h_w = 0)
Δh	H - h_w
R	Radius of influence, ft. R = L
	(If trench bottom is above the static gw level, then R = 0, and Q = 0)
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

Feature ID	Trench Segment (100-ft)				
D_{trench}	7.0	ft	Ground EL	100	ft msl
L_{trench}	100	ft	GW EL	99	ft msl
			Add-on (Max. GW EL)	0.0	ft
			Trench Bottom	93	ft msl

1. Calculation of radius of influence

Eq. 1 - Radius of influence

$$R = C\ (\Delta h)\sqrt{k}$$

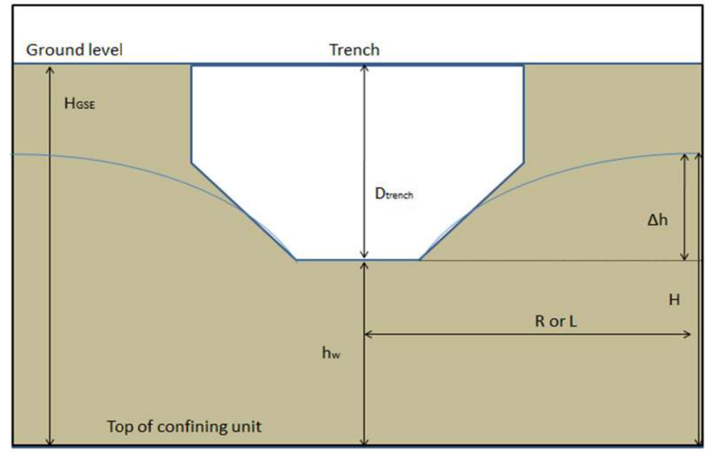
Δh (always ≥ 0)	6	ft			
C	3	-/-		3.2	ft/day
k	1.1E+01	µm/sec	k (Magothy, K)	1.1E-03	cm/sec
R, wit safety factor	30	ft	Safety Factor for R	0.5	

2. Calculation of estimated dewatering

Eq.2 - Required dewatering

$$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$$

H	50	ft
h_w	44	ft
k	3.7E-05	ft/sec
L	30	ft
Q	0.00052	cf/sec/ft
Q_{trench}	23.5	gpm



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft
	(If trench bottom is below confining unit, then h_w = 0)
Δh	H - h_w
R	Radius of influence, ft. R = L
	(If trench bottom is above the static gw level, then R = 0, and Q = 0)
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

Kmo (H = 10)

Feature ID | **Trench Segment (100-ft)**

D_{trench}	7.0	ft	Ground EL	100	ft msl
L_{trench}	100	ft	GW EL	99	ft msl
			Add-on (Max. GW EL)	0.0	ft
			Trench Bottom	93	ft msl

1. Calculation of radius of influence

Eq. 1 - Radius of influence

$$R = C\ (\Delta h)\sqrt{k}$$

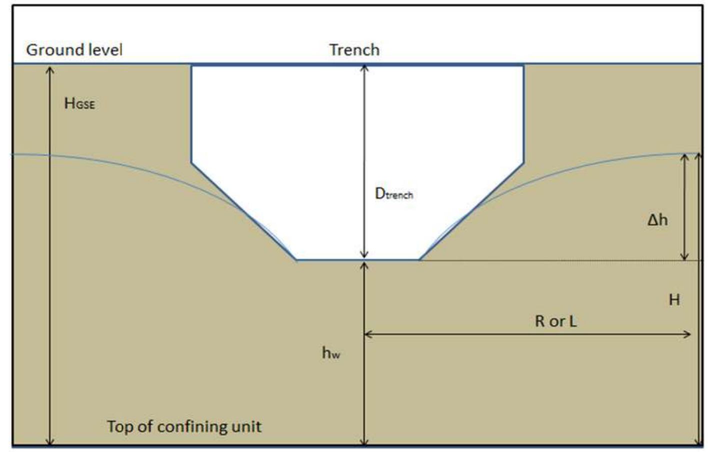
Δh (always ≥ 0)	6	ft			
C	3	-/-		8.7	ft/day
k	3.1E+01	µm/sec	k (Magothy, Kmo)	3.1E-03	cm/sec
R, wit safety factor	**50**	ft	Safety Factor for R	0.5	

2. Calculation of estimated dewatering

Eq.2 - Required dewatering

$$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$$

H	10	ft
h_w	4	ft
k	1.0E-04	ft/sec
L	50	ft
Q	0.00015	cf/sec/ft
Q_{trench}	**6.8**	gpm



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft *(If trench bottom is below confining unit, then h_w = 0)*
Δh	H - h_w
R	Radius of influence, ft. R = L *(If trench bottom is above the static gw level, then R = 0, and Q = 0)*
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

Kmo (H = 25)

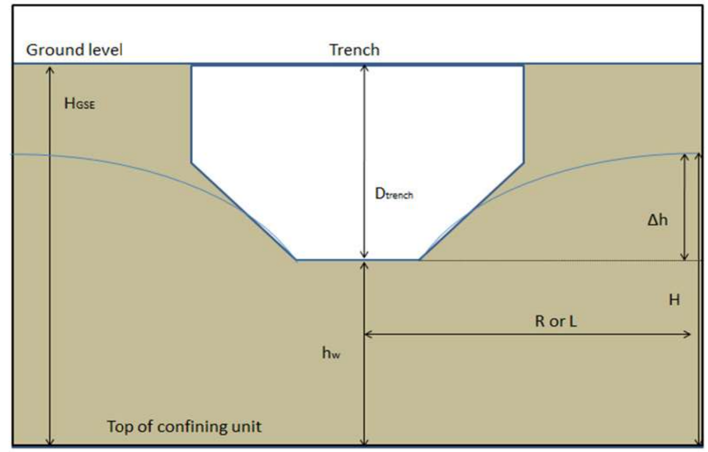
Feature ID	Trench Segment (100-ft)				
D_{trench}	7.0	ft	Ground EL	100	ft msl
L_{trench}	100	ft	GW EL	99	ft msl
			Add-on (Max. GW EL)	0.0	ft
			Trench Bottom	93	ft msl

1. Calculation of radius of influence

Δh (always ≥ 0)	6	ft	Eq. 1 - Radius of influence		
C	3	-/-	$R = C\ (\Delta h)\sqrt{k}$	8.7	ft/day
k	3.1E+01	µm/sec	k (Magothy, Kmo)	3.1E-03	cm/sec
R, wit safety factor	**50**	ft	Safety Factor for R	0.5	

2. Calculation of estimated dewatering

H	25	ft	Eq.2 - Required dewatering
h_w	19	ft	$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$
k	1.0E-04	ft/sec	
L	50	ft	
Q	0.00042	cf/sec/ft	
Q_{trench}	**19.0**	gpm	



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft
	(If trench bottom is below confining unit, then h_w = 0)
Δh	H - h_w
R	Radius of influence, ft. R = L
	(If trench bottom is above the static gw level, then R = 0, and Q = 0)
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

AECOM

Kmo (H = 50)

Feature ID | **Trench Segment (100-ft)**

D_{trench}	7.0	ft	Ground EL	100	ft msl
L_{trench}	100	ft	GW EL	99	ft msl
			Add-on (Max. GW EL)	0.0	ft
			Trench Bottom	93	ft msl

1. Calculation of radius of influence

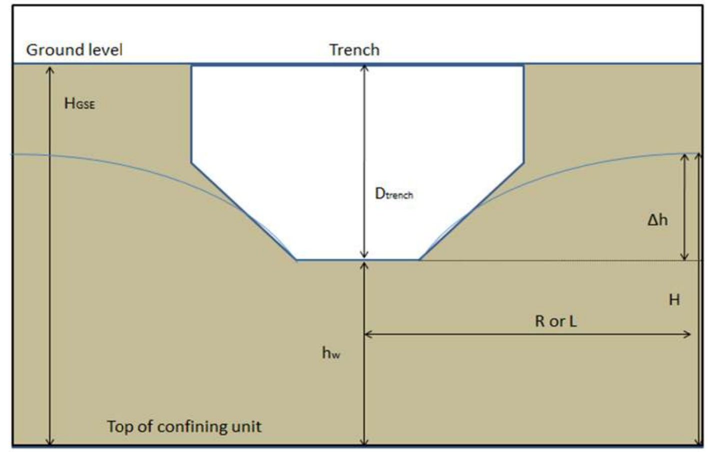
Δh (always ≥ 0)	6	ft	Eq. 1 - Radius of influence		
C	3	-/-	$R = C\ (\Delta h)\sqrt{k}$	8.7	ft/day
k	3.1E+01	µm/sec	k (Magothy, Kmo)	3.1E-03	cm/sec
R, wit safety factor	50	ft	Safety Factor for R	0.5	

2. Calculation of estimated dewatering

H	50	ft
h_w	44	ft
k	1.0E-04	ft/sec
L	50	ft
Q	0.00087	cf/sec/ft
Q_{trench}	39.0	gpm

Eq.2 - Required dewatering

$$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$$



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft
	(If trench bottom is below confining unit, then h_w = 0)
Δh	$H - h_w$
R	Radius of influence, ft. R = L
	(If trench bottom is above the static gw level, then R = 0, and Q = 0)
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

Kma (H = 10)

Feature ID | **Trench Segment (100-ft)**

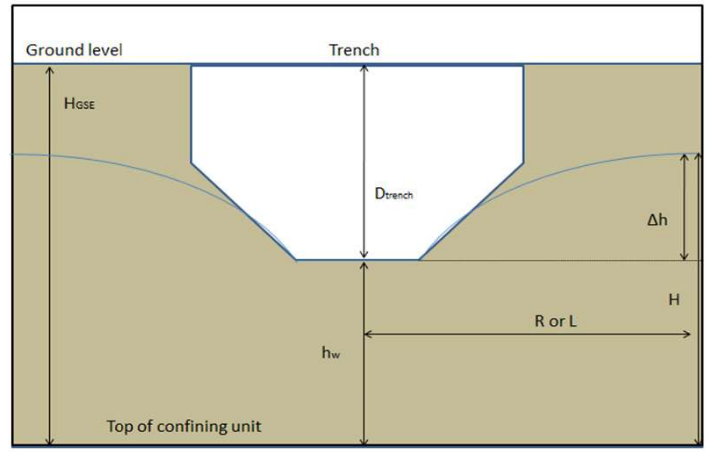
D_{trench}	7.0	ft	Ground EL	100	ft msl
L_{trench}	100	ft	GW EL	99	ft msl
			Add-on (Max. GW EL)	0.0	ft
			Trench Bottom	93	ft msl

1. Calculation of radius of influence

Δh (always $\geq$ 0)	6	ft	Eq. 1 - Radius of influence		
C	3	-/-	$R = C\ (\Delta h)\sqrt{k}$	1.3	ft/day
k	4.4E+00	µm/sec	k (Magothy, Kma)	4.4E-04	cm/sec
R, wit safety factor	19	ft	Safety Factor for R	0.5	

2. Calculation of estimated dewatering

H	10	ft	Eq.2 - Required dewatering
h_w	4	ft	$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$
k	1.5E-05	ft/sec	
L	19	ft	
Q	0.00006	cf/sec/ft	
Q_{trench}	2.6	gpm	



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft *(If trench bottom is below confining unit, then h_w = 0)*
Δh	H - h_w
R	Radius of influence, ft. R = L *(If trench bottom is above the static gw level, then R = 0, and Q = 0)*
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

Kma (H = 25)

Feature ID	Trench Segment (100-ft)			
D_{trench}	7.0 ft	Ground EL	100 ft msl	
L_{trench}	100 ft	GW EL	99 ft msl	
		Add-on (Max. GW EL)	0.0 ft	
		Trench Bottom	93 ft msl	

1. Calculation of radius of influence

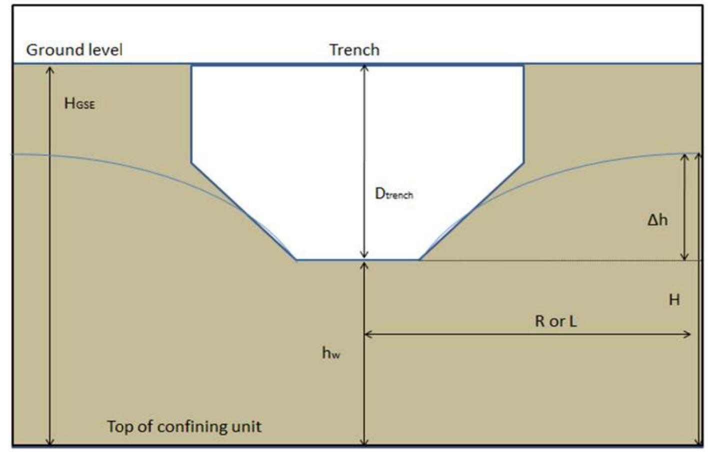
Δh (always > 0)	6	ft	Eq. 1 - Radius of influence	
C	3	-/-	$R = C\ (\Delta h)\sqrt{k}$	1.3 ft/day
k	4.4E+00	µm/sec	k (Magothy, Kma)	4.4E-04 cm/sec
R, wit safety factor	**19**	ft	Safety Factor for R	0.5

2. Calculation of estimated dewatering

H	25	ft
h_w	19	ft
k	1.5E-05	ft/sec
L	19	ft
Q	0.00016	cf/sec/ft
Q_{trench}	**7.2**	gpm

Eq.2 - Required dewatering

$$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$$



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft
	(If trench bottom is below confining unit, then h_w = 0)
Δh	H - h_w
R	Radius of influence, ft. R = L
	(If trench bottom is above the static gw level, then R = 0, and Q = 0)
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

Kma (H = 50)

Feature ID — **Trench Segment (100-ft)**

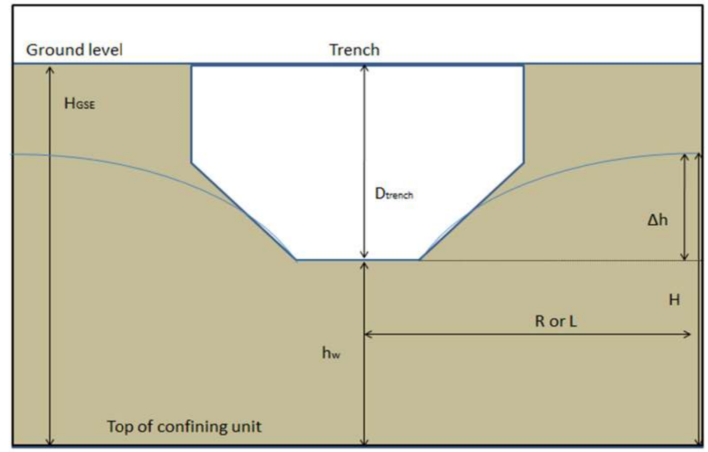
D_{trench}	7.0	ft	Ground EL	100	ft msl
L_{trench}	100	ft	GW EL	99	ft msl
			Add-on (Max. GW EL)	0.0	ft
			Trench Bottom	93	ft msl

1. Calculation of radius of influence

Δh (always ≥ 0)	6	ft	Eq. 1 - Radius of influence		
C	3	-/-	$R = C\,(\Delta h)\sqrt{k}$	1.3	ft/day
k	4.4E+00	µm/sec	k (Magothy, Kma)	4.4E-04	cm/sec
R, wit safety factor	19	ft	Safety Factor for R	0.5	

2. Calculation of estimated dewatering

H	50	ft	Eq.2 - Required dewatering
h_w	44	ft	$$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$$
k	1.5E-05	ft/sec	
L	19	ft	
Q	0.00033	cf/sec/ft	
Q_{trench}	14.8	gpm	



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft *(If trench bottom is below confining unit, then h_w = 0)*
Δh	$H - h_w$
R	Radius of influence, ft. R = L *(If trench bottom is above the static gw level, then R = 0, and Q = 0)*
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

AECOM

Qal (H=10)

Feature ID | **Trench Segment (100-ft)**

D_{trench}	7.0	ft	Ground EL	100	ft msl
L_{trench}	100	ft	GW EL	99	ft msl
			Add-on (Max. GW EL)	0.0	ft
			Trench Bottom	93	ft msl

1. Calculation of radius of influence

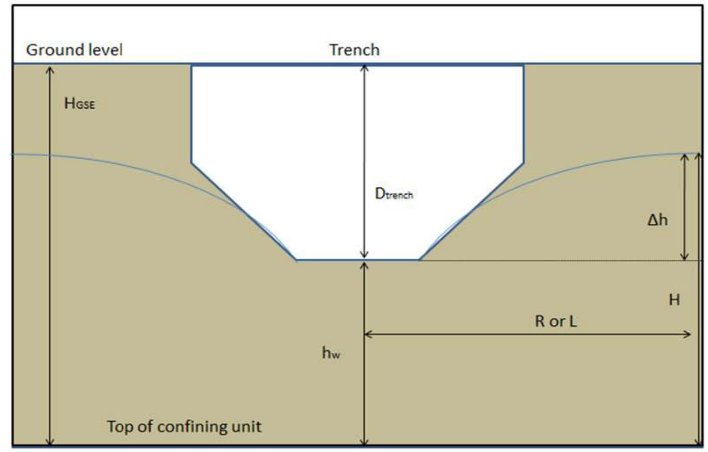
Δh (always ≥ 0)	6	ft	Eq. 1 - Radius of influence		
C	3	-/-	$R = C\ (\Delta h)\sqrt{k}$	19.8	ft/day
k	7.0E+01	µm/sec	k (Qal)	7.0E-03	cm/sec
R, wit safety factor	75	ft	Safety Factor for R	0.5	

2. Calculation of estimated dewatering

H	10	ft
h_w	4	ft
k	2.3E-04	ft/sec
L	75	ft
Q	0.00023	cf/sec/ft
Q_{trench}	10.3	gpm

Eq.2 - Required dewatering

$$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$$



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft *(If trench bottom is below confining unit, then h_w = 0)*
Δh	H - h_w
R	Radius of influence, ft. R = L *(If trench bottom is above the static gw level, then R = 0, and Q = 0)*
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

Qal (H=25)

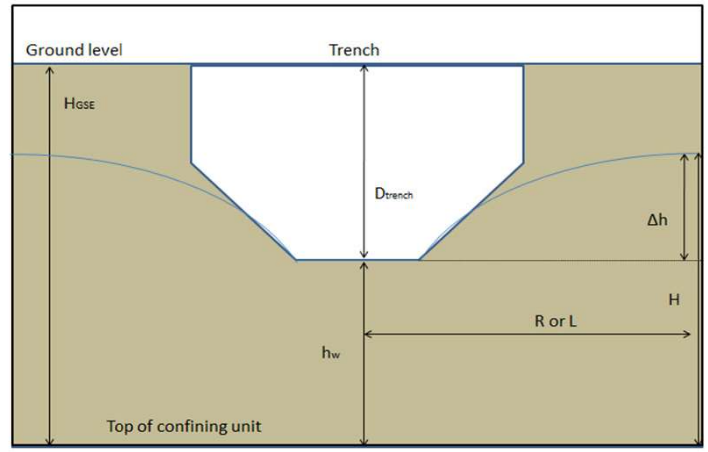
Feature ID	Trench Segment (100-ft)				
D_{trench}	7.0	ft	Ground EL	100	ft msl
L_{trench}	100	ft	GW EL	99	ft msl
			Add-on (Max. GW EL)	0.0	ft
			Trench Bottom	93	ft msl

1. Calculation of radius of influence

			Eq. 1 - Radius of influence		
Δh (always ≥ 0)	6	ft			
C	3	-/-	$R = C\ (\Delta h)\sqrt{k}$	19.8	ft/day
k	7.0E+01	µm/sec	k (Qal)	7.0E-03	cm/sec
R, wit safety factor	75	ft	Safety Factor for R	0.5	

2. Calculation of estimated dewatering

			Eq.2 - Required dewatering
H	25	ft	
h_w	19	ft	$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$
k	2.3E-04	ft/sec	
L	75	ft	
Q	0.00064	cf/sec/ft	
Q_{trench}	28.7	gpm	



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft *(If trench bottom is below confining unit, then h_w = 0)*
Δh	H - h_w
R	Radius of influence, ft. R = L *(If trench bottom is above the static gw level, then R = 0, and Q = 0)*
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

Qal (H=50)

Feature ID — **Trench Segment (100-ft)**

D_{trench}	7.0	ft	Ground EL	100	ft msl
L_{trench}	100	ft	GW EL	99	ft msl
			Add-on (Max. GW EL)	0.0	ft
			Trench Bottom	93	ft msl

1. Calculation of radius of influence

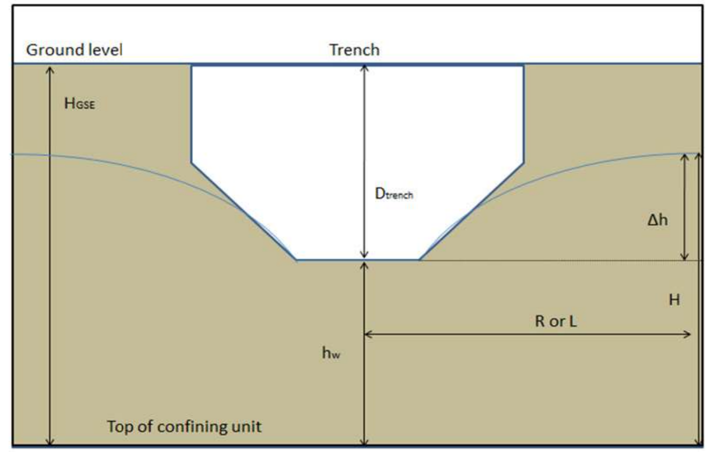
Δh (always ≥ 0)	6	ft	Eq. 1 - Radius of influence		
C	3	-/-	$R = C\ (\Delta h)\sqrt{k}$	19.8	ft/day
k	7.0E+01	µm/sec	k (Qal)	7.0E-03	cm/sec
R, wit safety factor	75	ft	Safety Factor for R	0.5	

2. Calculation of estimated dewatering

H	50	ft
h_w	44	ft
k	2.3E-04	ft/sec
L	75	ft
Q	0.00131	cf/sec/ft
Q_{trench}	58.9	gpm

Eq.2 - Required dewatering

$$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$$



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft
	(If trench bottom is below confining unit, then h_w = 0)
Δh	H - h_w
R	Radius of influence, ft. R = L
	(If trench bottom is above the static gw level, then R = 0, and Q = 0)
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

Mag (H=10)

Feature ID	Trench Segment (100-ft)				
D_{trench}	7.0	ft	Ground EL	100	ft msl
L_{trench}	100	ft	GW EL	99	ft msl
			Add-on (Max. GW EL)	0.0	ft
			Trench Bottom	93	ft msl

1. Calculation of radius of influence

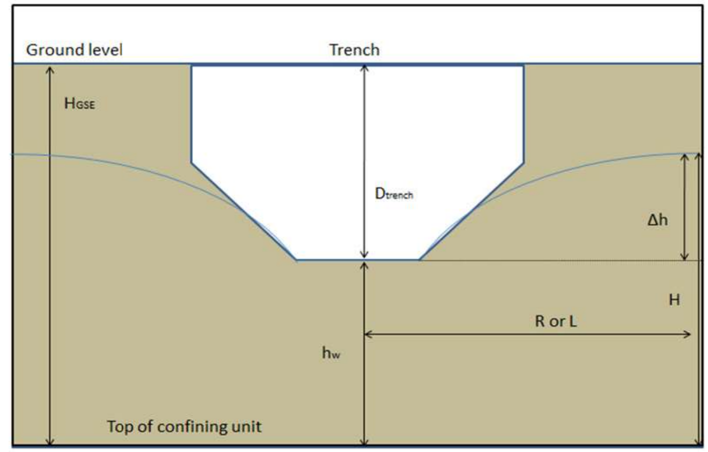
			Eq. 1 - Radius of influence		
Δh (always ≥ 0)	6	ft			
C	3	-/-	$R = C\ (\Delta h)\sqrt{k}$	15.9	ft/day
k	5.6E+01	μm/sec	k (Magothy, K)	5.6E-03	cm/sec
R, wit safety factor	67	ft	Safety Factor for R	0.5	

2. Calculation of estimated dewatering

Eq.2 - Required dewatering

$$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$$

H	10	ft
h_w	4	ft
k	1.8E-04	ft/sec
L	67	ft
Q	0.00020	cf/sec/ft
Q_{trench}	9.2	gpm



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft *(If trench bottom is below confining unit, then h_w = 0)*
Δh	H - h_w
R	Radius of influence, ft. R = L *(If trench bottom is above the static gw level, then R = 0, and Q = 0)*
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

AECOM

Mag (H=25)

Feature ID — **Trench Segment (100-ft)**

D_{trench}	7.0	ft	Ground EL	100	ft msl
L_{trench}	100	ft	GW EL	99	ft msl
			Add-on (Max. GW EL)	0.0	ft
			Trench Bottom	93	ft msl

1. Calculation of radius of influence

Eq. 1 - Radius of influence

$$R = C\ (\Delta h)\sqrt{k}$$

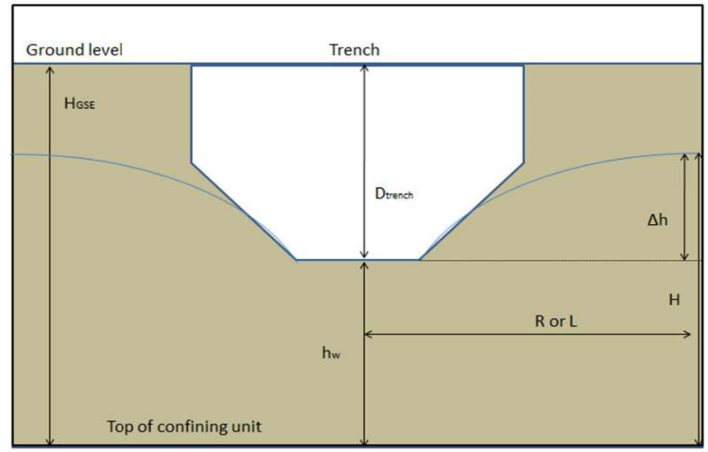
Δh (always ≥ 0)	6	ft			
C	3	-/-		15.9	ft/day
k	5.6E+01	µm/sec	k (Magothy, K)	5.6E-03	cm/sec
R, wit safety factor	67	ft	Safety Factor for R	0.5	Enter!

2. Calculation of estimated dewatering

Eq.2 - Required dewatering

$$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$$

H	25	ft
h_w	19	ft
k	1.8E-04	ft/sec
L	67	ft
Q	0.00057	cf/sec/ft
Q_{trench}	25.7	gpm



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft *(If trench bottom is below confining unit, then h_w = 0)*
Δh	H - h_w
R	Radius of influence, ft. R = L *(If trench bottom is above the static gw level, then R = 0, and Q = 0)*
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

Mag (H=50)

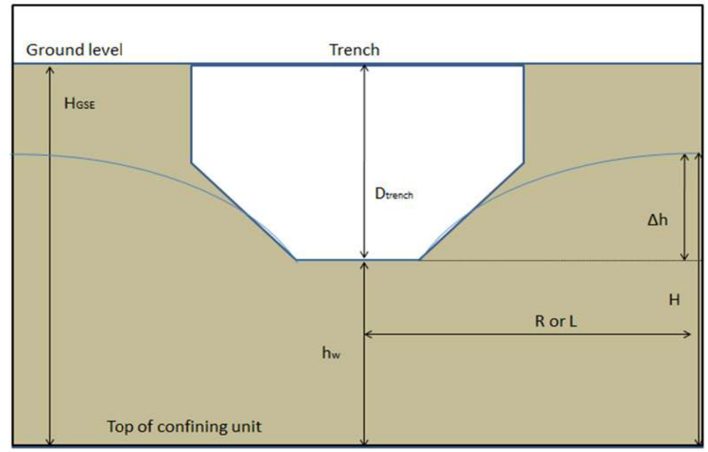
Feature ID	Trench Segment (100-ft)				
D_{trench}	7.0	ft	Ground EL	100	ft msl
L_{trench}	100	ft	GW EL	99	ft msl
			Add-on (Max. GW EL)	0.0	ft
			Trench Bottom	93	ft msl

1. Calculation of radius of influence

Δh (always ≥ 0)	6	ft	Eq. 1 - Radius of influence		
C	3	-/-	$R = C\ (\Delta h)\sqrt{k}$	15.9	ft/day
k	5.6E+01	µm/sec	k (Magothy, K)	5.6E-03	cm/sec
R, wit safety factor	67	ft	Safety Factor for R	0.5	

2. Calculation of estimated dewatering

H	50	ft	Eq.2 - Required dewatering
h_w	44	ft	$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$
k	1.8E-04	ft/sec	
L	67	ft	
Q	0.00117	cf/sec/ft	
Q_{trench}	52.6	gpm	



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft
	(If trench bottom is below confining unit, then h_w = 0)
Δh	H - h_w
R	Radius of influence, ft. R = L
	(If trench bottom is above the static gw level, then R = 0, and Q = 0)
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

AECOM

Kmo (H = 10)

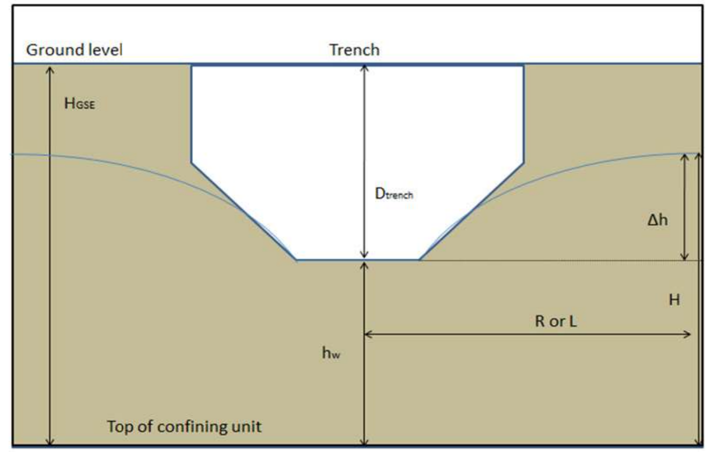
Feature ID			Trench Segment (100-ft)		
D_{trench}	7.0	ft	Ground EL	100	ft msl
L_{trench}	100	ft	GW EL	99	ft msl
			Add-on (Max. GW EL)	0.0	ft
			Trench Bottom	93	ft msl

1. Calculation of radius of influence

Δh (always ≥ 0)	6	ft	Eq. 1 - Radius of influence		
C	3	-/-	$R = C\ (\Delta h)\sqrt{k}$	43.5	ft/day
k	1.5E+02	µm/sec	k (Magothy, Kmo)	1.5E-02	cm/sec
R, wit safety factor	112	ft	Safety Factor for R	0.5	

2. Calculation of estimated dewatering

H	10	ft	Eq.2 - Required dewatering
h_w	4	ft	$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$
k	5.0E-04	ft/sec	
L	112	ft	
Q	0.00034	cf/sec/ft	
Q_{trench}	15.2	gpm	



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft *(If trench bottom is below confining unit, then h_w = 0)*
Δh	H - h_w
R	Radius of influence, ft. R = L *(If trench bottom is above the static gw level, then R = 0, and Q = 0)*
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

Kmo (H = 25)

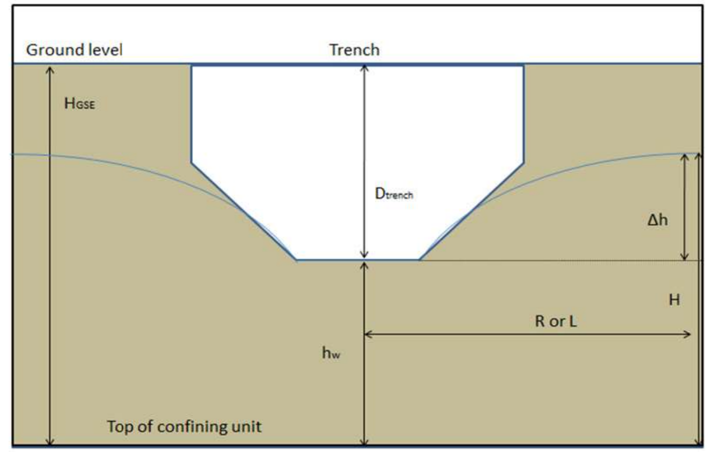
Feature ID	Trench Segment (100-ft)				
D_{trench}	7.0	ft	Ground EL	100	ft msl
L_{trench}	100	ft	GW EL	99	ft msl
			Add-on (Max. GW EL)	0.0	ft
			Trench Bottom	93	ft msl

1. Calculation of radius of influence

Δh (always ≥ 0)	6	ft	Eq. 1 - Radius of influence		
C	3	-/-	$R = C\ (\Delta h)\sqrt{k}$	43.5	ft/day
k	1.5E+02	µm/sec	k (Magothy, Kmo)	1.5E-02	cm/sec
R, wit safety factor	112	ft	Safety Factor for R	0.5	

2. Calculation of estimated dewatering

H	25	ft	Eq.2 - Required dewatering
h_w	19	ft	$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$
k	5.0E-04	ft/sec	
L	112	ft	
Q	0.00095	cf/sec/ft	
Q_{trench}	42.5	gpm	



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft
	(If trench bottom is below confining unit, then h_w = 0)
Δh	H - h_w
R	Radius of influence, ft. R = L
	(If trench bottom is above the static gw level, then R = 0, and Q = 0)
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

Kmo (H = 50)

Feature ID	Trench Segment (100-ft)			
D_{trench}	7.0 ft	Ground EL	100 ft msl	
L_{trench}	100 ft	GW EL	99 ft msl	
		Add-on (Max. GW EL)	0.0 ft	
		Trench Bottom	93 ft msl	

1. Calculation of radius of influence

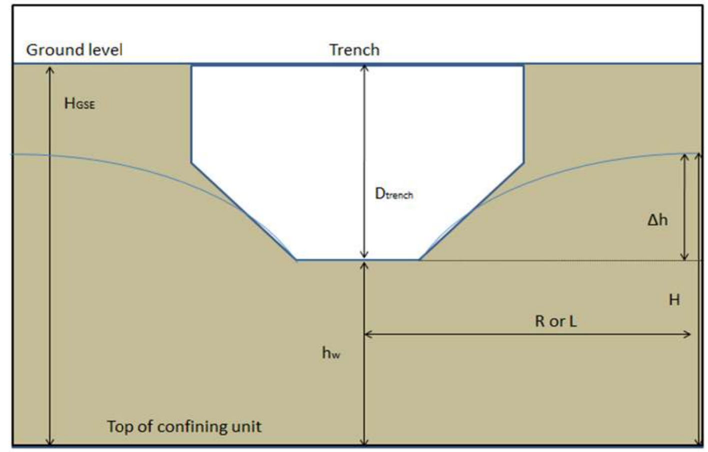
Δh (always ≥ 0)	6	ft	Eq. 1 - Radius of influence	
C	3	-/-	$R = C\ (\Delta h)\sqrt{k}$	43.5 ft/day
k	1.5E+02	µm/sec	k (Magothy, Kmo)	1.5E-02 cm/sec
R, wit safety factor	112	ft	Safety Factor for R	0.5

2. Calculation of estimated dewatering

H	50	ft
h_w	44	ft
k	5.0E-04	ft/sec
L	112	ft
Q	0.00194	cf/sec/ft
Q_{trench}	87.2	gpm

Eq.2 - Required dewatering

$$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$$



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft *(If trench bottom is below confining unit, then h_w = 0)*
Δh	H - h_w
R	Radius of influence, ft. R = L *(If trench bottom is above the static gw level, then R = 0, and Q = 0)*
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

Kma (H = 10)

Feature ID — **Trench Segment (100-ft)**

D_{trench}	7.0	ft	Ground EL	100	ft msl
L_{trench}	100	ft	GW EL	99	ft msl
			Add-on (Max. GW EL)	0.0	ft
			Trench Bottom	93	ft msl

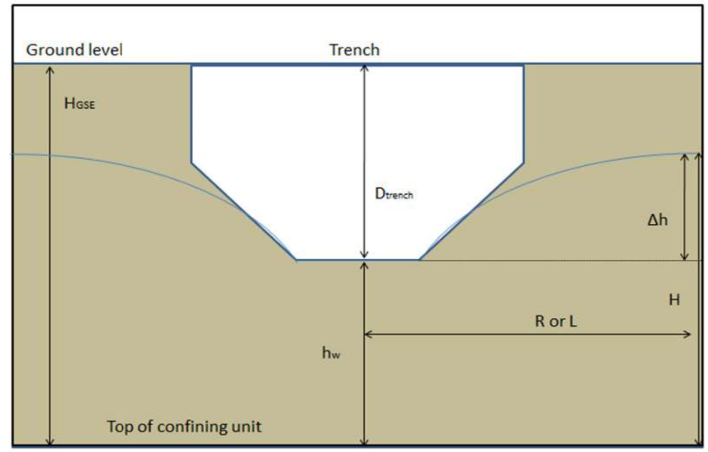
1. Calculation of radius of influence

Δh (always $\geq$ 0)	6	ft	Eq. 1 - Radius of influence		
C	3	-/-	$R = C\ (\Delta h)\sqrt{k}$	6.3	ft/day
k	2.2E+01	µm/sec	k (Magothy, Kma)	2.2E-03	cm/sec
R, wit safety factor	42	ft	Safety Factor for R	0.5	

2. Calculation of estimated dewatering

H	10	ft	Eq.2 - Required dewatering
h_w	4	ft	
k	7.3E-05	ft/sec	
L	42	ft	
Q	0.00013	cf/sec/ft	
Q_{trench}	5.8	gpm	

$$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$$



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft
	(If trench bottom is below confining unit, then h_w = 0)
Δh	H - h_w
R	Radius of influence, ft. R = L
	(If trench bottom is above the static gw level, then R = 0, and Q = 0)
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

AECOM

Kma (H = 25)

Feature ID | **Trench Segment (100-ft)**

D_{trench}	7.0	ft	Ground EL	100	ft msl
L_{trench}	100	ft	GW EL	99	ft msl
			Add-on (Max. GW EL)	0.0	ft
			Trench Bottom	93	ft msl

1. Calculation of radius of influence

Eq. 1 - Radius of influence

$$R = C\ (\Delta h)\sqrt{k}$$

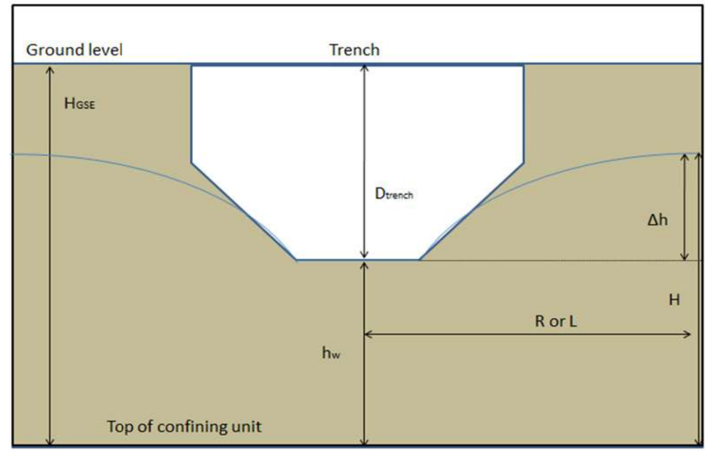
Δh (always $\geq$ 0)	6	ft			
C	3	-/-		6.3	ft/day
k	2.2E+01	µm/sec	k (Magothy, Kma)	2.2E-03	cm/sec
R, wit safety factor	**42**	ft	Safety Factor for R	0.5	

2. Calculation of estimated dewatering

Eq.2 - Required dewatering

$$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$$

H	25	ft
h_w	19	ft
k	7.3E-05	ft/sec
L	42	ft
Q	0.00036	cf/sec/ft
Q_{trench}	**16.2**	gpm



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft *(If trench bottom is below confining unit, then h_w = 0)*
Δh	H - h_w
R	Radius of influence, ft. R = L *(If trench bottom is above the static gw level, then R = 0, and Q = 0)*
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

Kma (H = 50)

Feature ID | **Trench Segment (100-ft)**

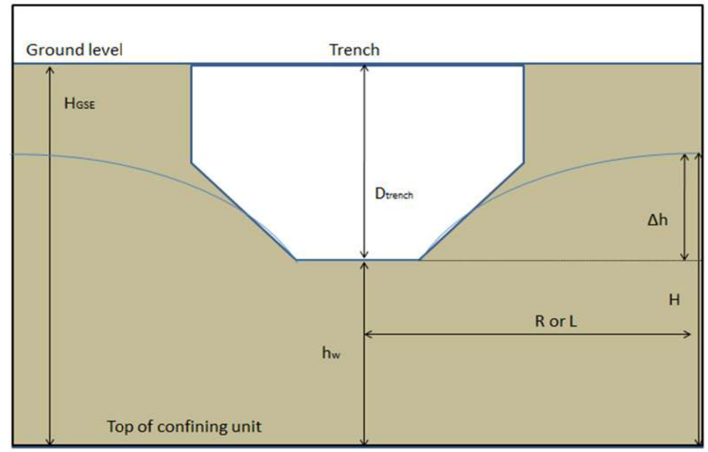
D_{trench}	7.0	ft	Ground EL	100	ft msl
L_{trench}	100	ft	GW EL	99	ft msl
			Add-on (Max. GW EL)	0.0	ft
			Trench Bottom	93	ft msl

1. Calculation of radius of influence

Δh (always ≥ 0)	6	ft	Eq. 1 - Radius of influence		
C	3	-/-	$R = C\ (\Delta h)\sqrt{k}$	6.3	ft/day
k	2.2E+01	µm/sec	k (Magothy, Kma)	2.2E-03	cm/sec
R, wit safety factor	42	ft	Safety Factor for R	0.5	

2. Calculation of estimated dewatering

H	50	ft	Eq.2 - Required dewatering
h_w	44	ft	$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$
k	7.3E-05	ft/sec	
L	42	ft	
Q	0.00074	cf/sec/ft	
Q_{trench}	33.2	gpm	



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft *(If trench bottom is below confining unit, then h_w = 0)*
Δh	H - h_w
R	Radius of influence, ft. R = L *(If trench bottom is above the static gw level, then R = 0, and Q = 0)*
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

Qal (H=10)

Feature ID — **Trench Segment (100-ft)**

D_{trench}	7.0	ft	Ground EL	100	ft msl
L_{trench}	100	ft	GW EL	99	ft msl
			Add-on (Max. GW EL)	0.0	ft
			Trench Bottom	93	ft msl

1. Calculation of radius of influence

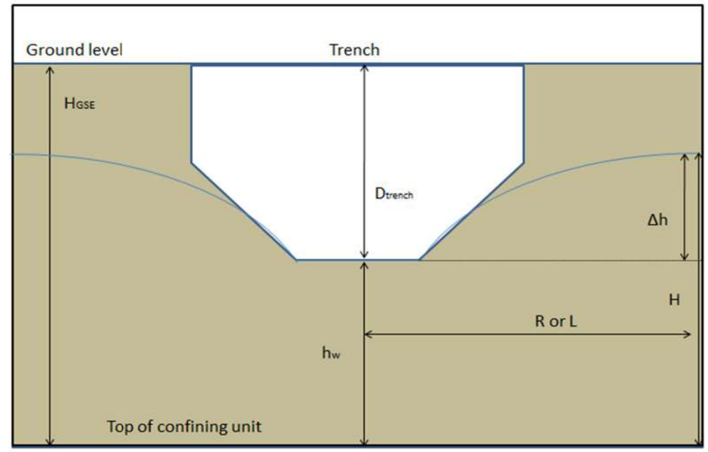
Δh (always ≥ 0)	6	ft	Eq. 1 - Radius of influence		
C	3	-/-	$R = C\ (\Delta h)\sqrt{k}$	99.2	ft/day
k	3.5E+02	µm/sec	k (Qal)	3.5E-02	cm/sec
R, wit safety factor	**168**	ft	Safety Factor for R	0.5	

2. Calculation of estimated dewatering

H	10	ft
h_w	4	ft
k	1.1E-03	ft/sec
L	168	ft
Q	0.00051	cf/sec/ft
Q_{trench}	**22.9**	gpm

Eq.2 - Required dewatering

$$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$$



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft *(If trench bottom is below confining unit, then h_w = 0)*
Δh	H - h_w
R	Radius of influence, ft. R = L *(If trench bottom is above the static gw level, then R = 0, and Q = 0)*
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

Qal (H=25)

Feature ID — **Trench Segment (100-ft)**

D_{trench}	7.0	ft	Ground EL	100	ft msl
L_{trench}	100	ft	GW EL	99	ft msl
			Add-on (Max. GW EL)	0.0	ft
			Trench Bottom	93	ft msl

1. Calculation of radius of influence

Eq. 1 - Radius of influence

$$R = C\ (\Delta h)\sqrt{k}$$

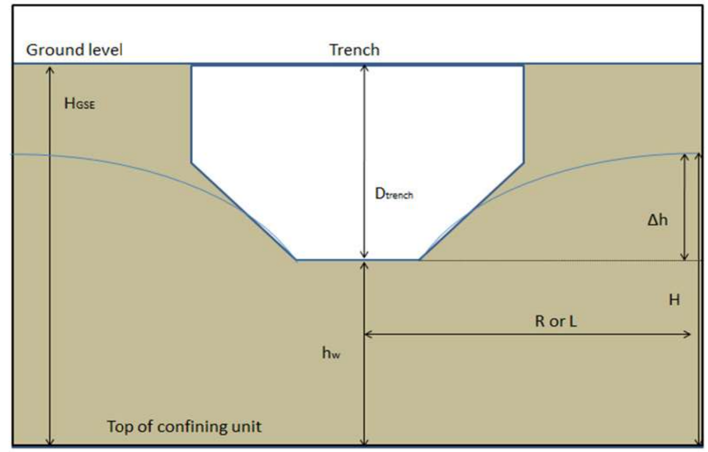
Δh (always ≥ 0)	6	ft			
C	3	-/-		99.2	ft/day
k	3.5E+02	µm/sec	k (Qal)	3.5E-02	cm/sec
R, wit safety factor	168	ft	Safety Factor for R	0.5	

2. Calculation of estimated dewatering

Eq.2 - Required dewatering

$$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$$

H	25	ft
h_w	19	ft
k	1.1E-03	ft/sec
L	168	ft
Q	0.00143	cf/sec/ft
Q_{trench}	64.2	gpm



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft *(If trench bottom is below confining unit, then h_w = 0)*
Δh	H - h_w
R	Radius of influence, ft. R = L *(If trench bottom is above the static gw level, then R = 0, and Q = 0)*
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

AECOM

Qal (H=50)

Feature ID | **Trench Segment (100-ft)**

D_{trench}	7.0	ft	Ground EL	100	ft msl
L_{trench}	100	ft	GW EL	99	ft msl
			Add-on (Max. GW EL)	0.0	ft
			Trench Bottom	93	ft msl

1. Calculation of radius of influence

Eq. 1 - Radius of influence

$$R = C\ (\Delta h)\sqrt{k}$$

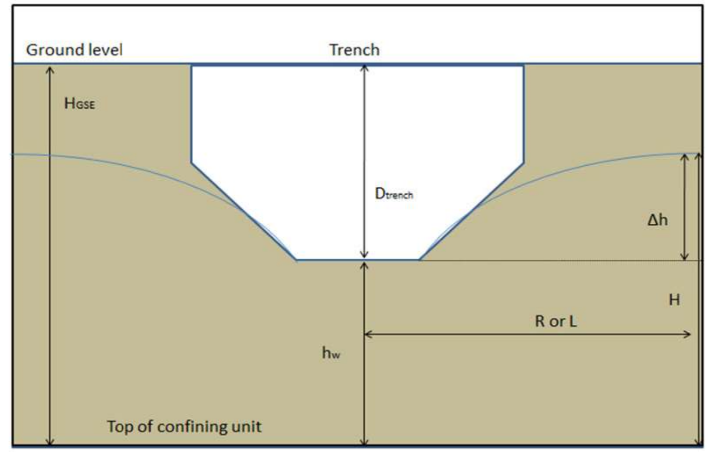
Δh (always > 0)	6	ft			
C	3	-/-		99.2	ft/day
k	3.5E+02	µm/sec	k (Qal)	3.5E-02	cm/sec
R, wit safety factor	168	ft	Safety Factor for R	0.5	

2. Calculation of estimated dewatering

Eq.2 - Required dewatering

$$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$$

H	50	ft
h_w	44	ft
k	1.1E-03	ft/sec
L	168	ft
Q	0.00293	cf/sec/ft
Q_{trench}	131.6	gpm



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft
	(If trench bottom is below confining unit, then h_w = 0)
Δh	H - h_w
R	Radius of influence, ft. R = L
	(If trench bottom is above the static gw level, then R = 0, and Q = 0)
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

Mag (H=10)

Feature ID — **Trench Segment (100-ft)**

D_{trench}	7.0	ft	Ground EL	100	ft msl
L_{trench}	100	ft	GW EL	99	ft msl
			Add-on (Max. GW EL)	0.0	ft
			Trench Bottom	93	ft msl

1. Calculation of radius of influence

Eq. 1 - Radius of influence

$$R = C\ (\Delta h)\sqrt{k}$$

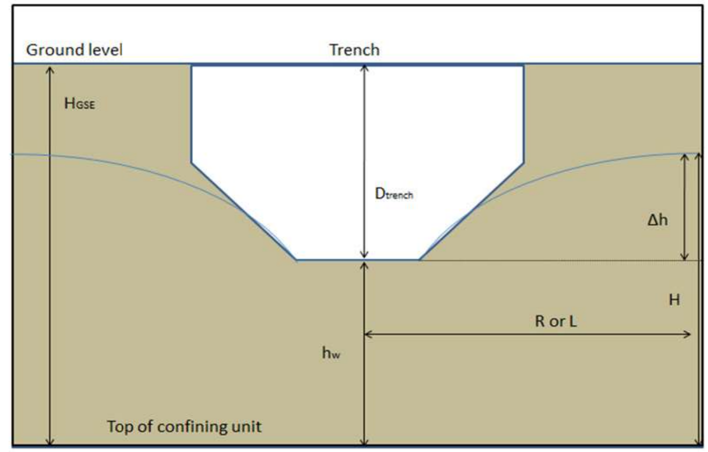
Δh (always ≥ 0)	6	ft			
C	3	-/-		79.3	ft/day
k	2.8E+02	µm/sec	k (Magothy, K)	2.8E-02	cm/sec
R, wit safety factor	151	ft	Safety Factor for R	0.5	

2. Calculation of estimated dewatering

Eq.2 - Required dewatering

$$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$$

H	10	ft
h_w	4	ft
k	9.2E-04	ft/sec
L	151	ft
Q	0.00046	cf/sec/ft
Q_{trench}	20.5	gpm



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft *(If trench bottom is below confining unit, then h_w = 0)*
Δh	H - h_w
R	Radius of influence, ft. R = L *(If trench bottom is above the static gw level, then R = 0, and Q = 0)*
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

Mag (H=25)

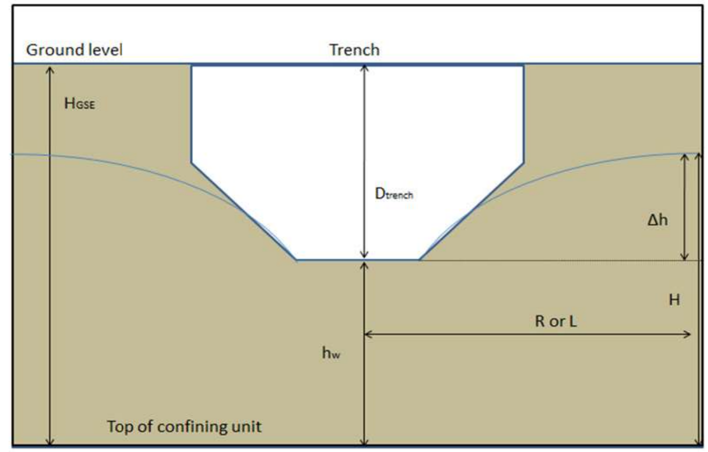
Feature ID			Trench Segment (100-ft)		
D_{trench}	7.0	ft	Ground EL	100	ft msl
L_{trench}	100	ft	GW EL	99	ft msl
			Add-on (Max. GW EL)	0.0	ft
			Trench Bottom	93	ft msl

1. Calculation of radius of influence

Δh (always $\geq$ 0)	6	ft	Eq. 1 - Radius of influence		
C	3	-/-	$R = C\ (\Delta h)\sqrt{k}$	79.3	ft/day
k	2.8E+02	µm/sec	k (Magothy, K)	2.8E-02	cm/sec
R, wit safety factor	151	ft	Safety Factor for R	0.5	Enter!

2. Calculation of estimated dewatering

H	25	ft	Eq.2 - Required dewatering
h_w	19	ft	$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$
k	9.2E-04	ft/sec	
L	151	ft	
Q	0.00128	cf/sec/ft	
Q_{trench}	57.4	gpm	



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft *(If trench bottom is below confining unit, then h_w = 0)*
Δh	H - h_w
R	Radius of influence, ft. R = L *(If trench bottom is above the static gw level, then R = 0, and Q = 0)*
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

Mag (H=50)

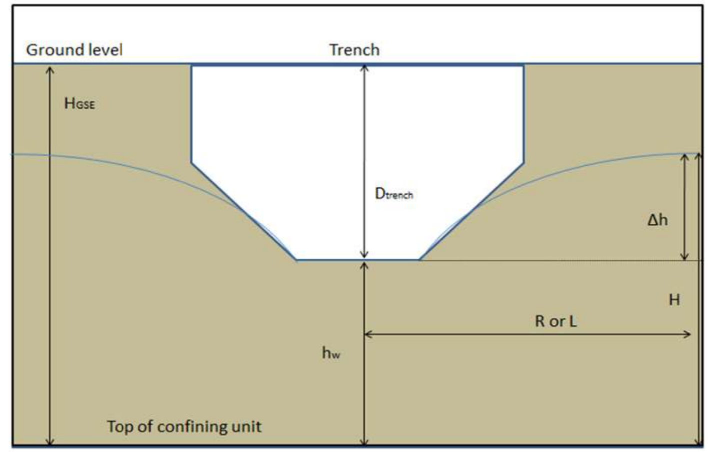
Feature ID	Trench Segment (100-ft)			
D_{trench}	7.0 ft	Ground EL	100 ft msl	
L_{trench}	100 ft	GW EL	99 ft msl	
		Add-on (Max. GW EL)	0.0 ft	
		Trench Bottom	93 ft msl	

1. Calculation of radius of influence

Δh (always $\geq$ 0)	6 ft	Eq. 1 - Radius of influence	
C	3 -/-	$R = C\ (\Delta h)\sqrt{k}$	79.3 ft/day
k	2.8E+02 µm/sec	k (Magothy, K)	2.8E-02 cm/sec
R, wit safety factor	151 ft	Safety Factor for R	0.5

2. Calculation of estimated dewatering

H	50 ft	Eq.2 - Required dewatering
h_w	44 ft	$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$
k	9.2E-04 ft/sec	
L	151 ft	
Q	0.00262 cf/sec/ft	
Q_{trench}	117.7 gpm	



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft *(If trench bottom is below confining unit, then h_w = 0)*
Δh	H - h_w
R	Radius of influence, ft. R = L *(If trench bottom is above the static gw level, then R = 0, and Q = 0)*
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

AECOM

Kmo (H = 10)

Feature ID	**Trench Segment (100-ft)**				
D_{trench}	7.0	ft	Ground EL	100	ft msl
L_{trench}	100	ft	GW EL	99	ft msl
			Add-on (Max. GW EL)	0.0	ft
			Trench Bottom	93	ft msl

1. Calculation of radius of influence

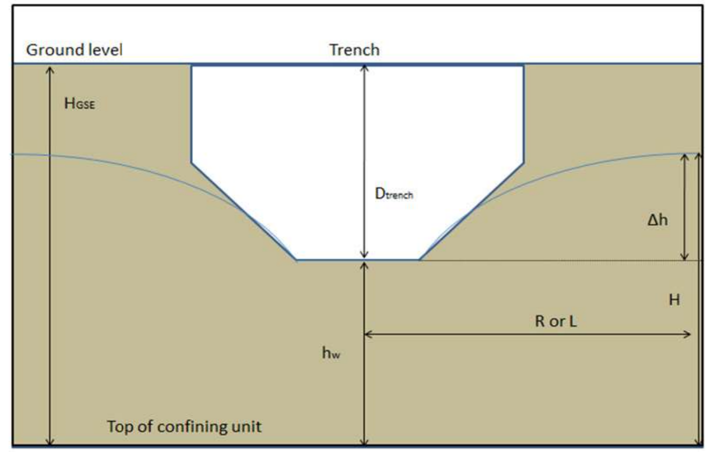
Δh (always $\geq$ 0)	6	ft	Eq. 1 - Radius of influence		
C	3	-/-	$R = C\ (\Delta h)\sqrt{k}$	217.7	ft/day
k	7.7E+02	µm/sec	k (Magothy, Kmo)	7.7E-02	cm/sec
R, wit safety factor	249	ft	Safety Factor for R	0.5	

2. Calculation of estimated dewatering

H	10	ft
h_w	4	ft
k	2.5E-03	ft/sec
L	249	ft
Q	0.00076	cf/sec/ft
Q_{trench}	34.0	gpm

Eq.2 - Required dewatering

$$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$$



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft *(If trench bottom is below confining unit, then h_w = 0)*
Δh	H - h_w
R	Radius of influence, ft. R = L *(If trench bottom is above the static gw level, then R = 0, and Q = 0)*
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

Kmo (H = 25)

Feature ID — **Trench Segment (100-ft)**

D_{trench}	7.0	ft	Ground EL	100	ft msl
L_{trench}	100	ft	GW EL	99	ft msl
			Add-on (Max. GW EL)	0.0	ft
			Trench Bottom	93	ft msl

1. Calculation of radius of influence

Eq. 1 - Radius of influence

$$R = C\ (\Delta h)\sqrt{k}$$

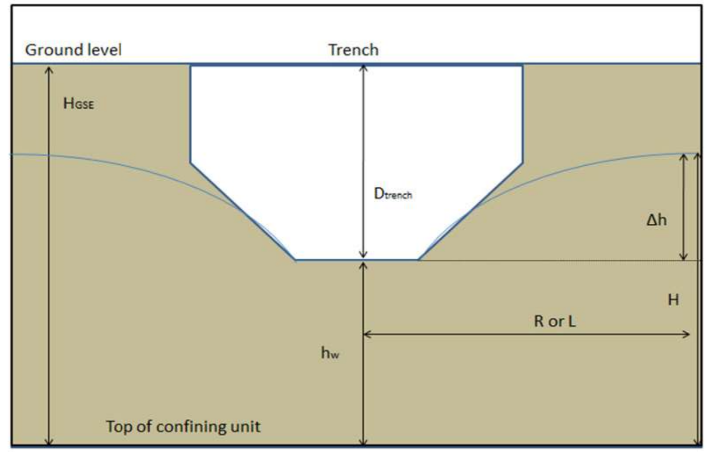
Δh (always ≥ 0)	6	ft			
C	3	-/-		217.7	ft/day
k	7.7E+02	µm/sec	k (Magothy, Kmo)	7.7E-02	cm/sec
R, wit safety factor	249	ft	Safety Factor for R	0.5	

2. Calculation of estimated dewatering

Eq.2 - Required dewatering

$$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$$

H	25	ft
h_w	19	ft
k	2.5E-03	ft/sec
L	249	ft
Q	0.00212	cf/sec/ft
Q_{trench}	95.1	gpm



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft *(If trench bottom is below confining unit, then h_w = 0)*
Δh	H - h_w
R	Radius of influence, ft. R = L *(If trench bottom is above the static gw level, then R = 0, and Q = 0)*
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

Kmo (H = 50)

Feature ID | **Trench Segment (100-ft)**

D_{trench}	7.0	ft	Ground EL	100	ft msl
L_{trench}	100	ft	GW EL	99	ft msl
			Add-on (Max. GW EL)	0.0	ft
			Trench Bottom	93	ft msl

1. Calculation of radius of influence

Eq. 1 - Radius of influence

$$R = C\ (\Delta h)\sqrt{k}$$

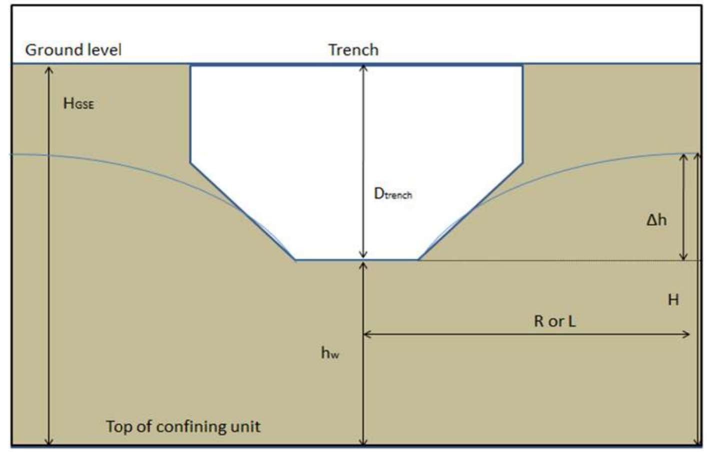
Δh (always ≥ 0)	6	ft			
C	3	-/-		217.7	ft/day
k	7.7E+02	µm/sec	k (Magothy, Kmo)	7.7E-02	cm/sec
R, wit safety factor	249	ft	Safety Factor for R	0.5	

2. Calculation of estimated dewatering

Eq.2 - Required dewatering

$$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$$

H	50	ft
h_w	44	ft
k	2.5E-03	ft/sec
L	249	ft
Q	0.00434	cf/sec/ft
Q_{trench}	194.9	gpm



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft *(If trench bottom is below confining unit, then h_w = 0)*
Δh	H - h_w
R	Radius of influence, ft. R = L *(If trench bottom is above the static gw level, then R = 0, and Q = 0)*
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

Kma (H = 10)

Feature ID	Trench Segment (100-ft)				
D_{trench}	7.0	ft	Ground EL	100	ft msl
L_{trench}	100	ft	GW EL	99	ft msl
			Add-on (Max. GW EL)	0.0	ft
			Trench Bottom	93	ft msl

1. Calculation of radius of influence

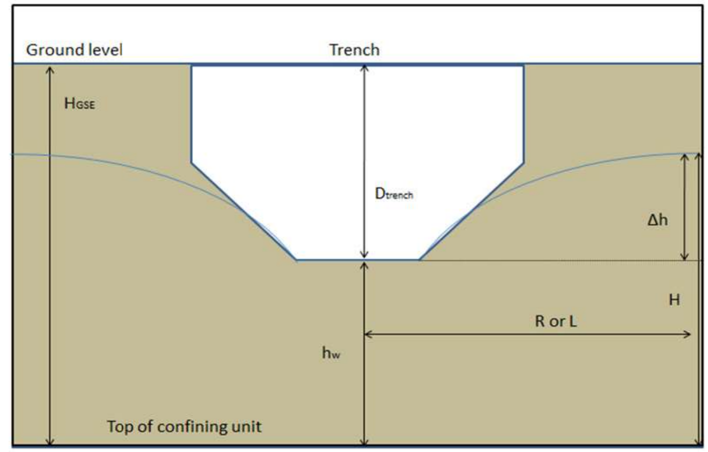
Δh (always ≥ 0)	6	ft	Eq. 1 - Radius of influence		
C	3	-/-	$R = C\ (\Delta h)\sqrt{k}$	31.5	ft/day
k	1.1E+02	µm/sec	k (Magothy, Kma)	1.1E-02	cm/sec
R, wit safety factor	95	ft	Safety Factor for R	0.5	

2. Calculation of estimated dewatering

H	10	ft
h_w	4	ft
k	3.6E-04	ft/sec
L	95	ft
Q	0.00029	cf/sec/ft
Q_{trench}	12.9	gpm

Eq.2 - Required dewatering

$$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$$



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft *(If trench bottom is below confining unit, then h_w = 0)*
Δh	$H - h_w$
R	Radius of influence, ft. R = L *(If trench bottom is above the static gw level, then R = 0, and Q = 0)*
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

Kma (H = 25)

Feature ID | **Trench Segment (100-ft)**

D_{trench}	7.0	ft	Ground EL	100	ft msl
L_{trench}	100	ft	GW EL	99	ft msl
			Add-on (Max. GW EL)	0.0	ft
			Trench Bottom	93	ft msl

1. Calculation of radius of influence

Eq. 1 - Radius of influence

$$R = C\ (\Delta h)\sqrt{k}$$

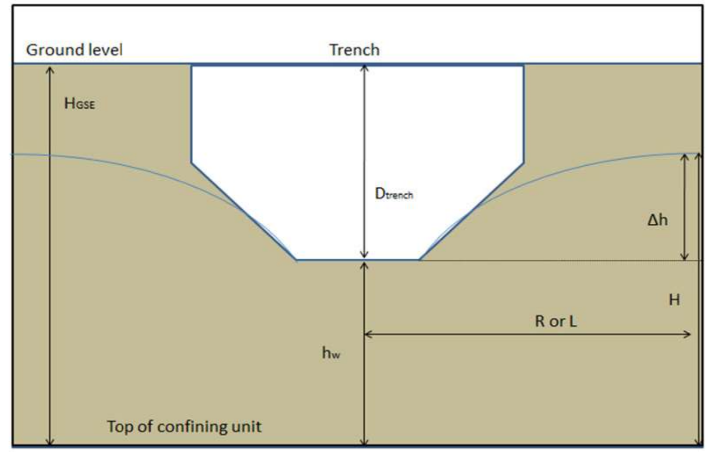
Δh (always ≥ 0)	6	ft			
C	3	-/-		31.5	ft/day
k	1.1E+02	µm/sec	k (Magothy, Kma)	1.1E-02	cm/sec
R, wit safety factor	95	ft	Safety Factor for R	0.5	

2. Calculation of estimated dewatering

Eq.2 - Required dewatering

$$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$$

H	25	ft
h_w	19	ft
k	3.6E-04	ft/sec
L	95	ft
Q	0.00081	cf/sec/ft
Q_{trench}	36.2	gpm



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft *(If trench bottom is below confining unit, then h_w = 0)*
Δh	H - h_w
R	Radius of influence, ft. R = L *(If trench bottom is above the static gw level, then R = 0, and Q = 0)*
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

AECOM

Kma (H = 50)

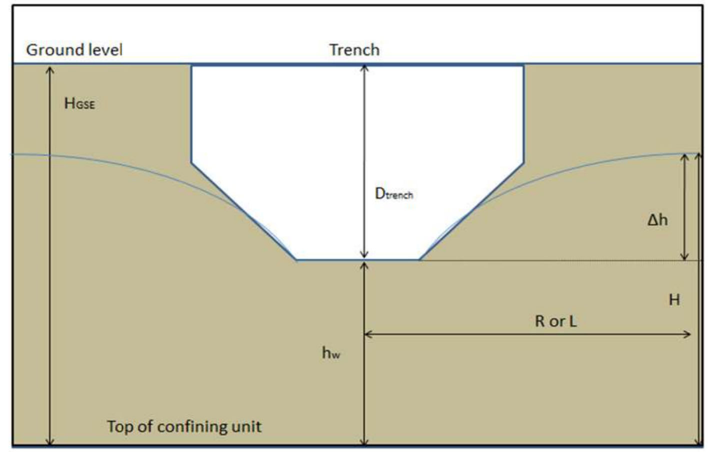
Feature ID	Trench Segment (100-ft)				
D_{trench}	7.0	ft	Ground EL	100	ft msl
L_{trench}	100	ft	GW EL	99	ft msl
			Add-on (Max. GW EL)	0.0	ft
			Trench Bottom	93	ft msl

1. Calculation of radius of influence

Δh (always ≥ 0)	6	ft	Eq. 1 - Radius of influence		
C	3	-/-	$R = C\ (\Delta h)\sqrt{k}$	31.5	ft/day
k	1.1E+02	µm/sec	k (Magothy, Kma)	1.1E-02	cm/sec
R, wit safety factor	95	ft	Safety Factor for R	0.5	

2. Calculation of estimated dewatering

H	50	ft	Eq.2 - Required dewatering
h_w	44	ft	$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$
k	3.6E-04	ft/sec	
L	95	ft	
Q	0.00165	cf/sec/ft	
Q_{trench}	74.2	gpm	



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft
	(If trench bottom is below confining unit, then h_w = 0)
Δh	H - h_w
R	Radius of influence, ft. R = L
	(If trench bottom is above the static gw level, then R = 0, and Q = 0)
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

Qal (H=10)

Feature ID — **Trench Segment (100-ft)**

D_{trench}	12.0	ft	Ground EL	100	ft msl
L_{trench}	100	ft	GW EL	99	ft msl
			Add-on (Max. GW EL)	0.0	ft
			Trench Bottom	88	ft msl

1. Calculation of radius of influence

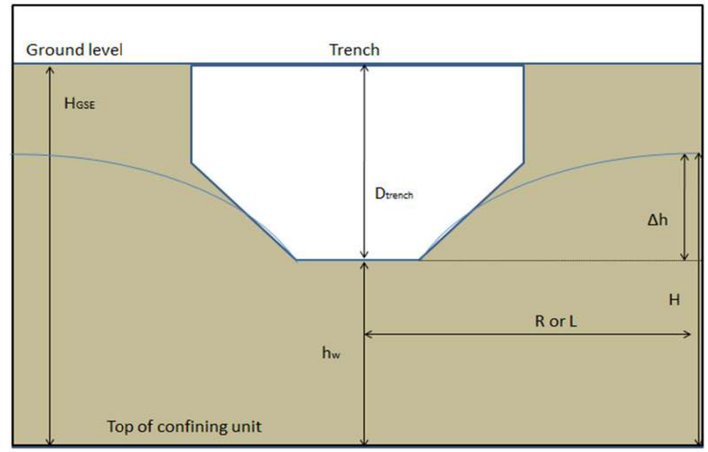
Δh (always ≥ 0)	11	ft	Eq. 1 - Radius of influence		
C	3	-/-	$R = C\ (\Delta h)\sqrt{k}$	4.0	ft/day
k	1.4E+01	µm/sec	k (Qal)	1.4E-03	cm/sec
R, wit safety factor	62	ft	Safety Factor for R	0.5	

2. Calculation of estimated dewatering

H	10	ft
h_w	-1	ft
k	4.6E-05	ft/sec
L	62	ft
Q	0.00008	cf/sec/ft
Q_{trench}	3.4	gpm

Eq.2 - Required dewatering

$$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$$



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft
	(If trench bottom is below confining unit, then h_w = 0)
Δh	H - h_w
R	Radius of influence, ft. R = L
	(If trench bottom is above the static gw level, then R = 0, and Q = 0)
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

Qal (H=25)

Feature ID — **Trench Segment (100-ft)**

D_{trench}	12.0	ft	Ground EL	100	ft msl
L_{trench}	100	ft	GW EL	99	ft msl
			Add-on (Max. GW EL)	0.0	ft
			Trench Bottom	88	ft msl

1. Calculation of radius of influence

Eq. 1 - Radius of influence

$$R = C\ (\Delta h)\sqrt{k}$$

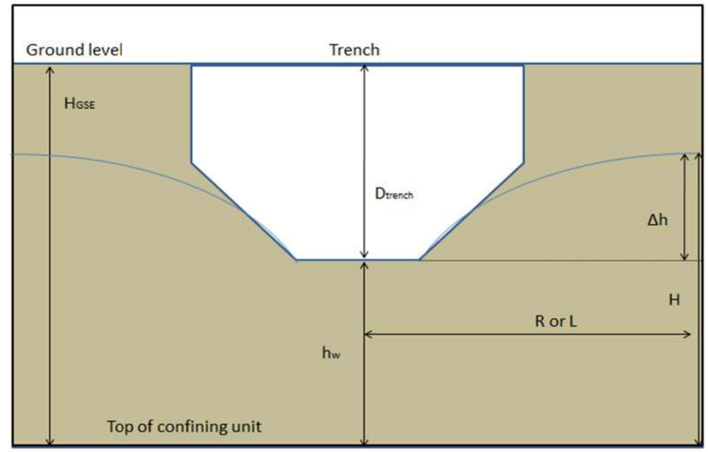
Δh (always ≥ 0)	11	ft			
C	3	-/-		4.0	ft/day
k	1.4E+01	µm/sec	k (Qal)	1.4E-03	cm/sec
R, wit safety factor	62	ft	Safety Factor for R	0.5	

2. Calculation of estimated dewatering

Eq.2 - Required dewatering

$$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$$

H	25	ft
h_w	14	ft
k	4.6E-05	ft/sec
L	62	ft
Q	0.00027	cf/sec/ft
Q_{trench}	12.2	gpm



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft
	(If trench bottom is below confining unit, then h_w = 0)
Δh	H - h_w
R	Radius of influence, ft. R = L
	(If trench bottom is above the static gw level, then R = 0, and Q = 0)
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

Feature ID — **Trench Segment (100-ft)**

D_{trench}	12.0	ft	Ground EL	100	ft msl
L_{trench}	100	ft	GW EL	99	ft msl
			Add-on (Max. GW EL)	0.0	ft
			Trench Bottom	88	ft msl

1. Calculation of radius of influence

Eq. 1 - Radius of influence

$$R = C\ (\Delta h)\sqrt{k}$$

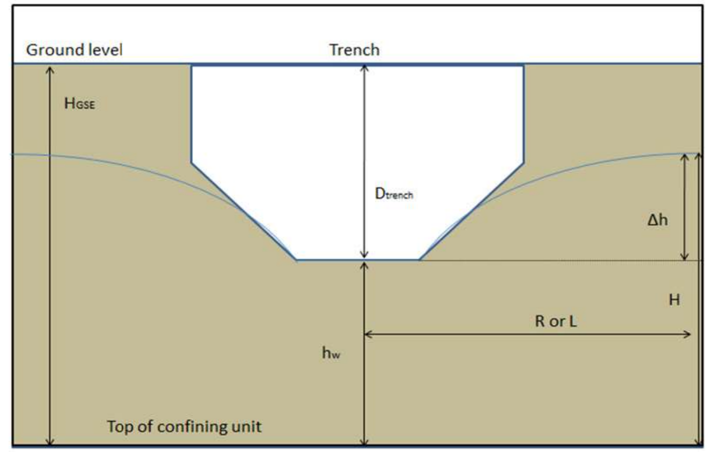
Δh (always ≥ 0)	11	ft			
C	3	-/-		4.0	ft/day
k	1.4E+01	µm/sec	k (Qal)	1.4E-03	cm/sec
R, wit safety factor	62	ft	Safety Factor for R	0.5	

2. Calculation of estimated dewatering

Eq.2 - Required dewatering

$$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$$

H	50	ft
h_w	39	ft
k	4.6E-05	ft/sec
L	62	ft
Q	0.00057	cf/sec/ft
Q_{trench}	25.8	gpm



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft *(If trench bottom is below confining unit, then h_w = 0)*
Δh	H - h_w
R	Radius of influence, ft. R = L *(If trench bottom is above the static gw level, then R = 0, and Q = 0)*
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

Mag (H=10)

Feature ID	Trench Segment (100-ft)				
D_{trench}	12.0 ft	Ground EL	100	ft msl	
L_{trench}	100 ft	GW EL	99	ft msl	
		Add-on (Max. GW EL)	0.0	ft	
		Trench Bottom	88	ft msl	

1. Calculation of radius of influence

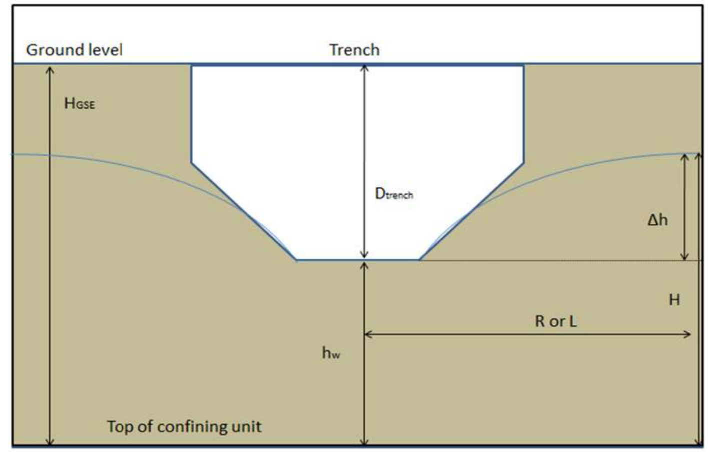
			Eq. 1 - Radius of influence		
Δh (always ≥ 0)	11	ft			
C	3	-/-	$R = C\,(\Delta h)\sqrt{k}$	3.2	ft/day
k	1.1E+01	µm/sec	k (Magothy, K)	1.1E-03	cm/sec
R, wit safety factor	55	ft	Safety Factor for R	0.5	

2. Calculation of estimated dewatering

H	10	ft
h_w	-1	ft
k	3.7E-05	ft/sec
L	55	ft
Q	0.00007	cf/sec/ft
Q_{trench}	3.0	gpm

Eq.2 - Required dewatering

$$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$$



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft *(If trench bottom is below confining unit, then h_w = 0)*
Δh	H - h_w
R	Radius of influence, ft. R = L *(If trench bottom is above the static gw level, then R = 0, and Q = 0)*
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

Mag (H=25)

Feature ID — **Trench Segment (100-ft)**

D_{trench}	12.0	ft	Ground EL	100	ft msl
L_{trench}	100	ft	GW EL	99	ft msl
			Add-on (Max. GW EL)	0.0	ft
			Trench Bottom	88	ft msl

1. Calculation of radius of influence

Eq. 1 - Radius of influence

$$R = C\ (\Delta h)\sqrt{k}$$

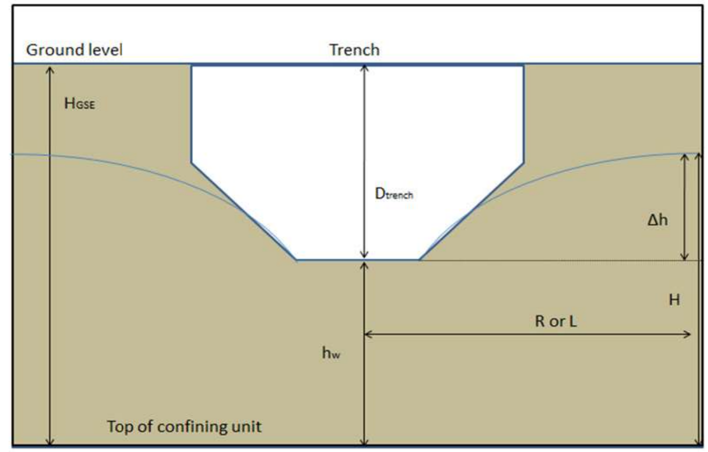
Δh (always $\geq$ 0)	11	ft			
C	3	-/-		3.2	ft/day
k	1.1E+01	µm/sec	k (Magothy, K)	1.1E-03	cm/sec
R, wit safety factor	55	ft	Safety Factor for R	0.5	Enter!

2. Calculation of estimated dewatering

Eq.2 - Required dewatering

$$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$$

H	25	ft
h_w	14	ft
k	3.7E-05	ft/sec
L	55	ft
Q	0.00024	cf/sec/ft
Q_{trench}	10.9	gpm



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft *(If trench bottom is below confining unit, then h_w = 0)*
Δh	H - h_w
R	Radius of influence, ft. R = L *(If trench bottom is above the static gw level, then R = 0, and Q = 0)*
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

Mag (H=50)

Feature ID | **Trench Segment (100-ft)**

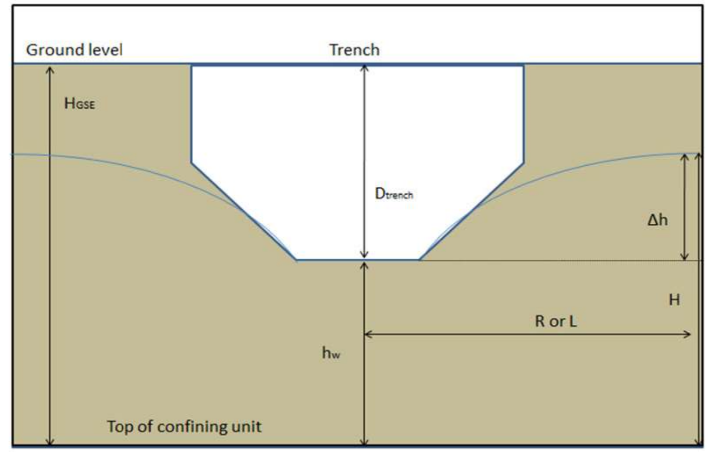
D_{trench}	12.0	ft	Ground EL	100	ft msl
L_{trench}	100	ft	GW EL	99	ft msl
			Add-on (Max. GW EL)	0.0	ft
			Trench Bottom	88	ft msl

1. Calculation of radius of influence

Δh (always $\geq$ 0)	11	ft	Eq. 1 - Radius of influence		
C	3	-/-	$R = C\ (\Delta h)\sqrt{k}$	3.2	ft/day
k	1.1E+01	µm/sec	k (Magothy, K)	1.1E-03	cm/sec
R, wit safety factor	55	ft	Safety Factor for R	0.5	

2. Calculation of estimated dewatering

H	50	ft	Eq.2 - Required dewatering
h_w	39	ft	$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$
k	3.7E-05	ft/sec	
L	55	ft	
Q	0.00051	cf/sec/ft	
Q_{trench}	23.1	gpm	



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft *(If trench bottom is below confining unit, then h_w = 0)*
Δh	H - h_w
R	Radius of influence, ft. R = L *(If trench bottom is above the static gw level, then R = 0, and Q = 0)*
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

Kmo (H = 10)

Feature ID | **Trench Segment (100-ft)**

D_{trench}	12.0	ft	Ground EL	100	ft msl
L_{trench}	100	ft	GW EL	99	ft msl
			Add-on (Max. GW EL)	0.0	ft
			Trench Bottom	88	ft msl

1. Calculation of radius of influence

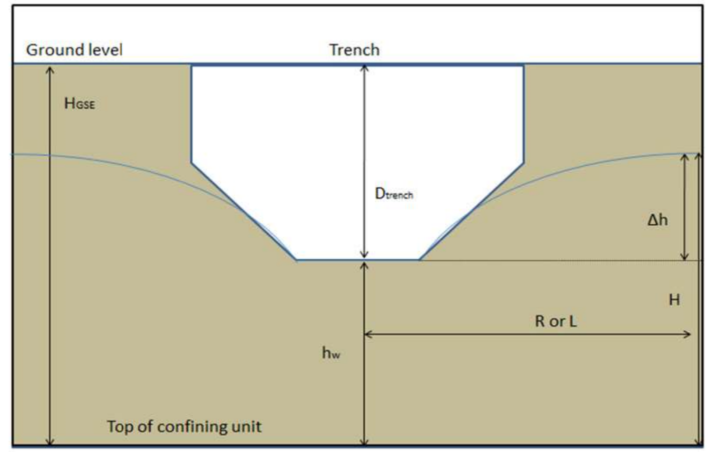
Δh (always ≥ 0)	11	ft	Eq. 1 - Radius of influence		
C	3	-/-	$R = C\ (\Delta h)\sqrt{k}$	8.7	ft/day
k	3.1E+01	µm/sec	k (Magothy, Kmo)	3.1E-03	cm/sec
R, wit safety factor	91	ft	Safety Factor for R	0.5	

2. Calculation of estimated dewatering

Eq.2 - Required dewatering

$$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$$

H	10	ft
h_w	-1	ft
k	1.0E-04	ft/sec
L	91	ft
Q	0.00011	cf/sec/ft
Q_{trench}	5.0	gpm



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft
	(If trench bottom is below confining unit, then h_w = 0)
Δh	H - h_w
R	Radius of influence, ft. R = L
	(If trench bottom is above the static gw level, then R = 0, and Q = 0)
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

Kmo (H = 25)

Feature ID		Trench Segment (100-ft)		
D_{trench}	12.0 ft	Ground EL	100	ft msl
L_{trench}	100 ft	GW EL	99	ft msl
		Add-on (Max. GW EL)	0.0	ft
		Trench Bottom	88	ft msl

1. Calculation of radius of influence

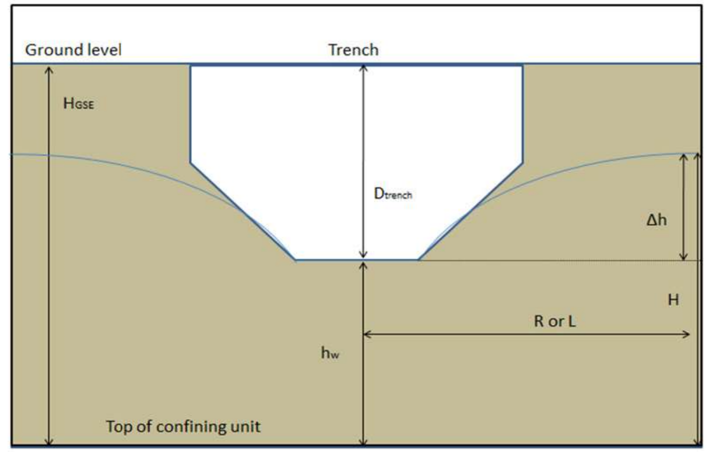
Δh (always ≥ 0)	11 ft	Eq. 1 - Radius of influence		
C	3 -/-	$R = C\ (\Delta h)\sqrt{k}$	8.7	ft/day
k	3.1E+01 µm/sec	k (Magothy, Kmo)	3.1E-03	cm/sec
R, wit safety factor	91 ft	Safety Factor for R	0.5	

2. Calculation of estimated dewatering

H	25	ft
h_w	14	ft
k	1.0E-04	ft/sec
L	91	ft
Q	0.00040	cf/sec/ft
Q_{trench}	18.0	gpm

Eq.2 - Required dewatering

$$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$$



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft *(If trench bottom is below confining unit, then h_w = 0)*
Δh	H - h_w
R	Radius of influence, ft. R = L *(If trench bottom is above the static gw level, then R = 0, and Q = 0)*
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

Kmo (H = 50)

Feature ID		Trench Segment (100-ft)			
D_{trench}	12.0	ft	Ground EL	100	ft msl
L_{trench}	100	ft	GW EL	99	ft msl
			Add-on (Max. GW EL)	0.0	ft
			Trench Bottom	88	ft msl

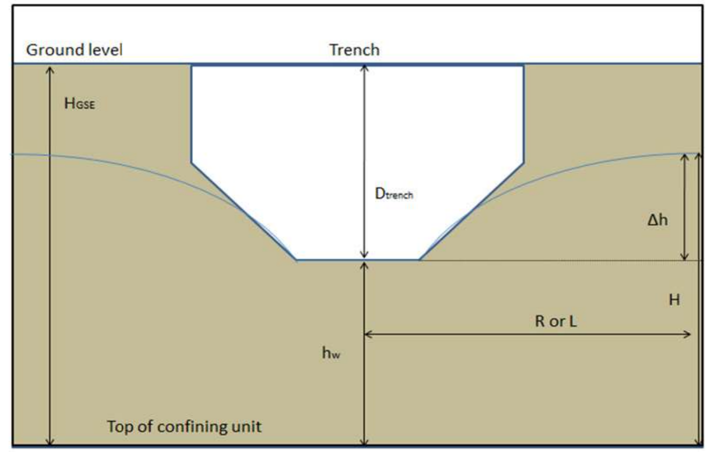
1. Calculation of radius of influence

Δh (always ≥ 0)	11	ft	Eq. 1 - Radius of influence		
C	3	-/-	$R = C\ (\Delta h)\sqrt{k}$	8.7	ft/day
k	3.1E+01	µm/sec	k (Magothy, Kmo)	3.1E-03	cm/sec
R, wit safety factor	91	ft	Safety Factor for R	0.5	

2. Calculation of estimated dewatering

H	50	ft	Eq.2 - Required dewatering
h_w	39	ft	
k	1.0E-04	ft/sec	
L	91	ft	
Q	0.00085	cf/sec/ft	
Q_{trench}	38.2	gpm	

$$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$$



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft *(If trench bottom is below confining unit, then h_w = 0)*
Δh	H - h_w
R	Radius of influence, ft. R = L *(If trench bottom is above the static gw level, then R = 0, and Q = 0)*
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

Kma (H = 10)

Feature ID — **Trench Segment (100-ft)**

D_{trench}	12.0	ft	Ground EL	100	ft msl
L_{trench}	100	ft	GW EL	99	ft msl
			Add-on (Max. GW EL)	0.0	ft
			Trench Bottom	88	ft msl

1. Calculation of radius of influence

Eq. 1 - Radius of influence

$$R = C\ (\Delta h)\sqrt{k}$$

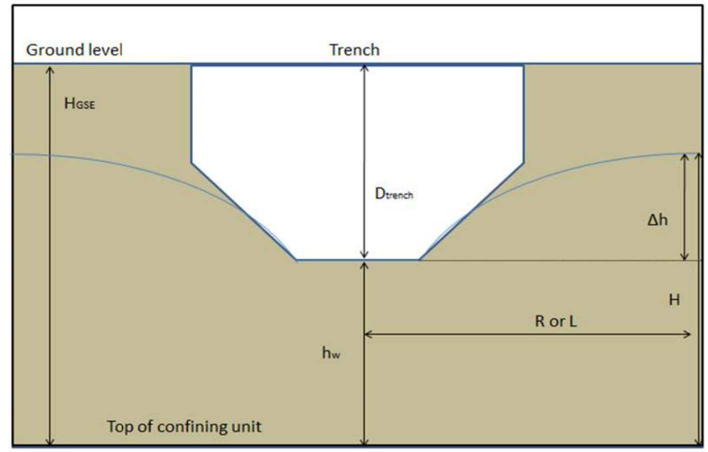
Δh (always ≥ 0)	11	ft			
C	3	-/-		1.3	ft/day
k	4.4E+00	µm/sec	k (Magothy, Kma)	4.4E-04	cm/sec
R, wit safety factor	35	ft	Safety Factor for R	0.5	

2. Calculation of estimated dewatering

Eq.2 - Required dewatering

$$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$$

H	10	ft
h_w	-1	ft
k	1.5E-05	ft/sec
L	35	ft
Q	0.00004	cf/sec/ft
Q_{trench}	1.9	gpm



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft *(If trench bottom is below confining unit, then h_w = 0)*
Δh	H - h_w
R	Radius of influence, ft. R = L *(If trench bottom is above the static gw level, then R = 0, and Q = 0)*
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

AECOM

Kma (H = 25)

Feature ID | **Trench Segment (100-ft)**

D_{trench}	12.0	ft	Ground EL	100	ft msl
L_{trench}	100	ft	GW EL	99	ft msl
			Add-on (Max. GW EL)	0.0	ft
			Trench Bottom	88	ft msl

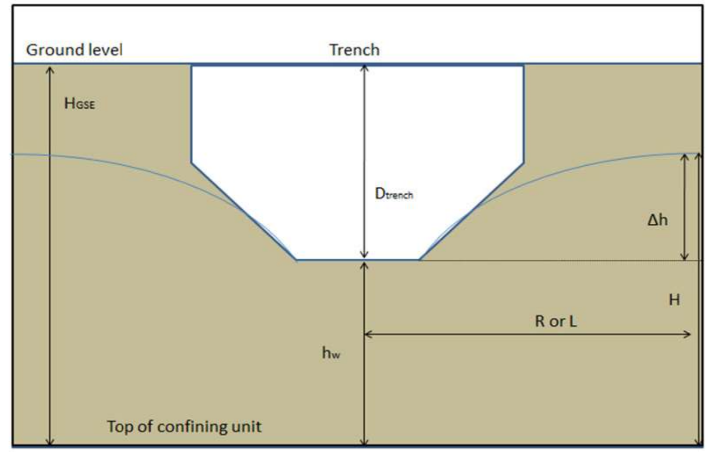
1. Calculation of radius of influence

Δh (always ≥ 0)	11	ft	Eq. 1 - Radius of influence		
C	3	-/-	$R = C\ (\Delta h)\sqrt{k}$	1.3	ft/day
k	4.4E+00	µm/sec	k (Magothy, Kma)	4.4E-04	cm/sec
R, wit safety factor	35	ft	Safety Factor for R	0.5	

2. Calculation of estimated dewatering

H	25	ft	Eq.2 - Required dewatering
h_w	14	ft	
k	1.5E-05	ft/sec	
L	35	ft	
Q	0.00015	cf/sec/ft	
Q_{trench}	6.9	gpm	

$$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$$



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft
	(If trench bottom is below confining unit, then h_w = 0)
Δh	H - h_w
R	Radius of influence, ft. R = L
	(If trench bottom is above the static gw level, then R = 0, and Q = 0)
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

AECOM

Kma (H = 50)

Feature ID	Trench Segment (100-ft)				
D_{trench}	12.0	ft	Ground EL	100	ft msl
L_{trench}	100	ft	GW EL	99	ft msl
			Add-on (Max. GW EL)	0.0	ft
			Trench Bottom	88	ft msl

1. Calculation of radius of influence

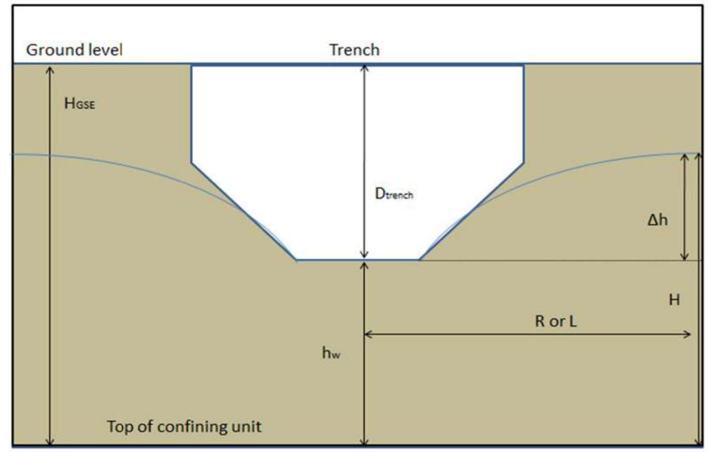
			Eq. 1 - Radius of influence		
Δh (always ≥ 0)	11	ft			
C	3	-/-	$R = C\ (\Delta h)\sqrt{k}$	1.3	ft/day
k	4.4E+00	µm/sec	k (Magothy, Kma)	4.4E-04	cm/sec
R, wit safety factor	35	ft	Safety Factor for R	0.5	

2. Calculation of estimated dewatering

Eq.2 - Required dewatering

$$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$$

H	50	ft
h_w	39	ft
k	1.5E-05	ft/sec
L	35	ft
Q	0.00032	cf/sec/ft
Q_{trench}	14.5	gpm



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft *(If trench bottom is below confining unit, then h_w = 0)*
Δh	H - h_w
R	Radius of influence, ft. R = L *(If trench bottom is above the static gw level, then R = 0, and Q = 0)*
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

Qal (H=10)

Feature ID | **Trench Segment (100-ft)**

D_{trench}	12.0	ft	Ground EL	100	ft msl
L_{trench}	100	ft	GW EL	99	ft msl
			Add-on (Max. GW EL)	0.0	ft
			Trench Bottom	88	ft msl

1. Calculation of radius of influence

Eq. 1 - Radius of influence

$$R = C\ (\Delta h)\sqrt{k}$$

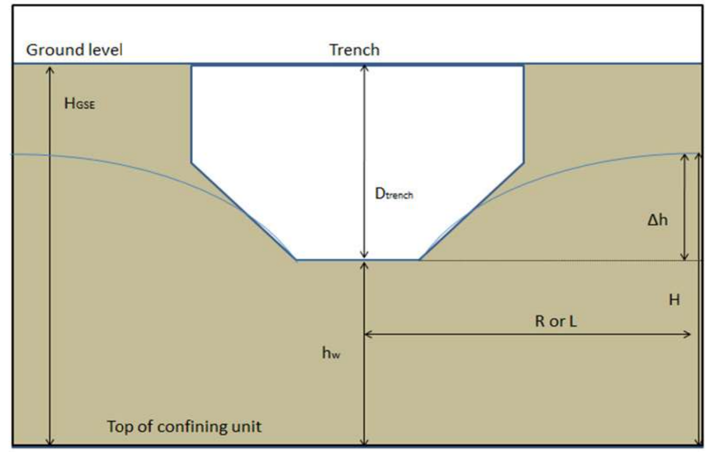
Δh (always ≥ 0)	11	ft			
C	3	-/-		19.8	ft/day
k	7.0E+01	µm/sec	k (Qal)	7.0E-03	cm/sec
R, wit safety factor	**138**	ft	Safety Factor for R	0.5	

2. Calculation of estimated dewatering

Eq.2 - Required dewatering

$$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$$

H	10	ft
h_w	-1	ft
k	2.3E-04	ft/sec
L	138	ft
Q	0.00017	cf/sec/ft
Q_{trench}	**7.6**	gpm



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft *(If trench bottom is below confining unit, then h_w = 0)*
Δh	H - h_w
R	Radius of influence, ft. R = L *(If trench bottom is above the static gw level, then R = 0, and Q = 0)*
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

Qal (H=25)

Feature ID — **Trench Segment (100-ft)**

D_{trench}	12.0	ft	Ground EL	100	ft msl
L_{trench}	100	ft	GW EL	99	ft msl
			Add-on (Max. GW EL)	0.0	ft
			Trench Bottom	88	ft msl

1. Calculation of radius of influence

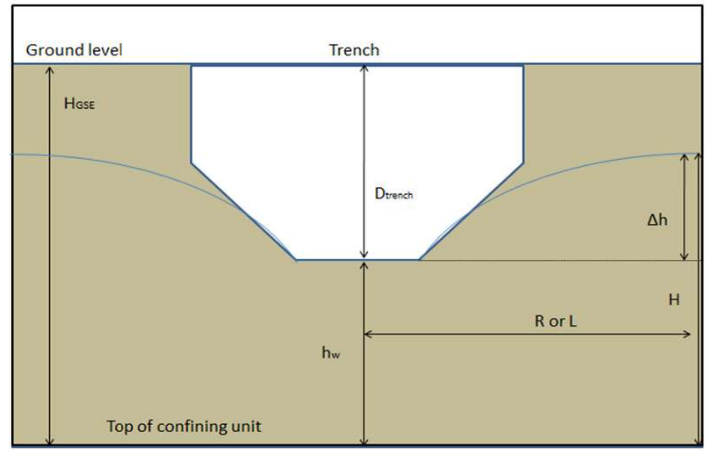
Δh (always ≥ 0)	11	ft	Eq. 1 - Radius of influence		
C	3	-/-	$R = C\ (\Delta h)\sqrt{k}$	19.8	ft/day
k	7.0E+01	µm/sec	k (Qal)	7.0E-03	cm/sec
R, wit safety factor	138	ft	Safety Factor for R	0.5	

2. Calculation of estimated dewatering

H	25	ft
h_w	14	ft
k	2.3E-04	ft/sec
L	138	ft
Q	0.00061	cf/sec/ft
Q_{trench}	27.2	gpm

Eq.2 - Required dewatering

$$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$$



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft *(If trench bottom is below confining unit, then h_w = 0)*
Δh	H - h_w
R	Radius of influence, ft. R = L *(If trench bottom is above the static gw level, then R = 0, and Q = 0)*
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

Qal (H=50)

Feature ID	Trench Segment (100-ft)			
D_{trench}	12.0 ft	Ground EL	100	ft msl
L_{trench}	100 ft	GW EL	99	ft msl
		Add-on (Max. GW EL)	0.0	ft
		Trench Bottom	88	ft msl

1. Calculation of radius of influence

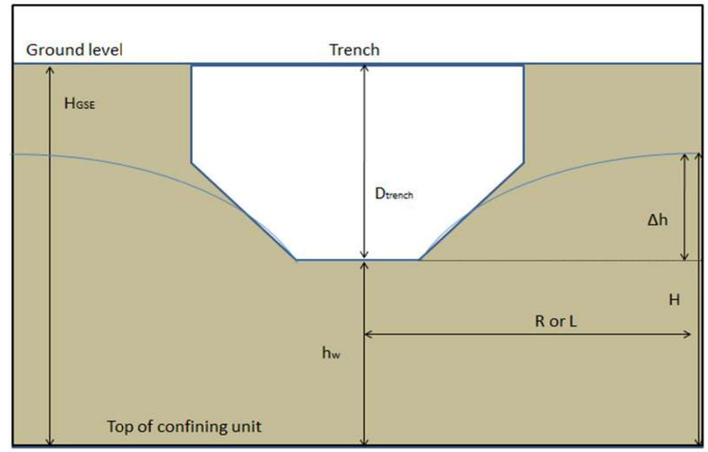
			Eq. 1 - Radius of influence		
Δh (always ≥ 0)	11	ft	$R = C\ (\Delta h)\sqrt{k}$	19.8	ft/day
C	3	-/-			
k	7.0E+01	µm/sec	k (Qal)	7.0E-03	cm/sec
R, wit safety factor	138	ft	Safety Factor for R	0.5	

2. Calculation of estimated dewatering

H	50	ft
h_w	39	ft
k	2.3E-04	ft/sec
L	138	ft
Q	0.00129	cf/sec/ft
Q_{trench}	57.7	gpm

Eq.2 - Required dewatering

$$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$$



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft *(If trench bottom is below confining unit, then h_w = 0)*
Δh	H - h_w
R	Radius of influence, ft. R = L *(If trench bottom is above the static gw level, then R = 0, and Q = 0)*
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

Mag (H=10)

Feature ID	Trench Segment (100-ft)			
D_{trench}	12.0 ft	Ground EL	100	ft msl
L_{trench}	100 ft	GW EL	99	ft msl
		Add-on (Max. GW EL)	0.0	ft
		Trench Bottom	88	ft msl

1. Calculation of radius of influence

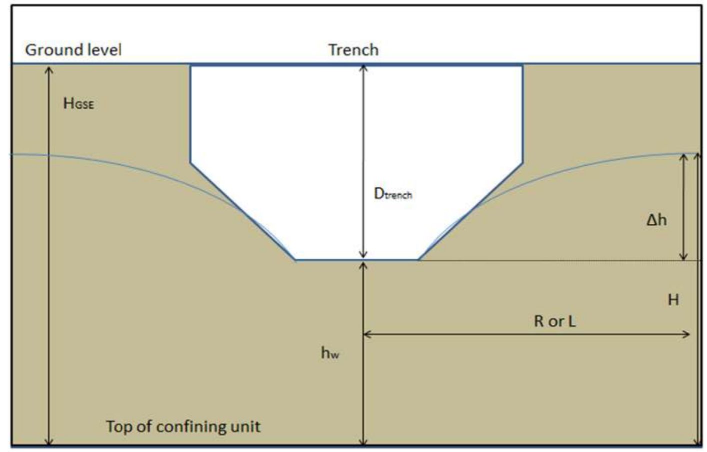
Δh (always $\geq$ 0)	11 ft	Eq. 1 - Radius of influence		
C	3 -/-	$R = C\ (\Delta h)\sqrt{k}$	15.9	ft/day
k	5.6E+01 µm/sec	k (Magothy, K)	5.6E-03	cm/sec
R, wit safety factor	**123** ft	Safety Factor for R	0.5	

2. Calculation of estimated dewatering

H	10 ft
h_w	-1 ft
k	1.8E-04 ft/sec
L	123 ft
Q	0.00015 cf/sec/ft
Q_{trench}	**6.8** gpm

Eq.2 - Required dewatering

$$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$$



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft
	(If trench bottom is below confining unit, then h_w = 0)
Δh	H - h_w
R	Radius of influence, ft. R = L
	(If trench bottom is above the static gw level, then R = 0, and Q = 0)
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

Mag (H=25)

Feature ID	Trench Segment (100-ft)				
D_{trench}	12.0	ft	Ground EL	100	ft msl
L_{trench}	100	ft	GW EL	99	ft msl
			Add-on (Max. GW EL)	0.0	ft
			Trench Bottom	88	ft msl

1. Calculation of radius of influence

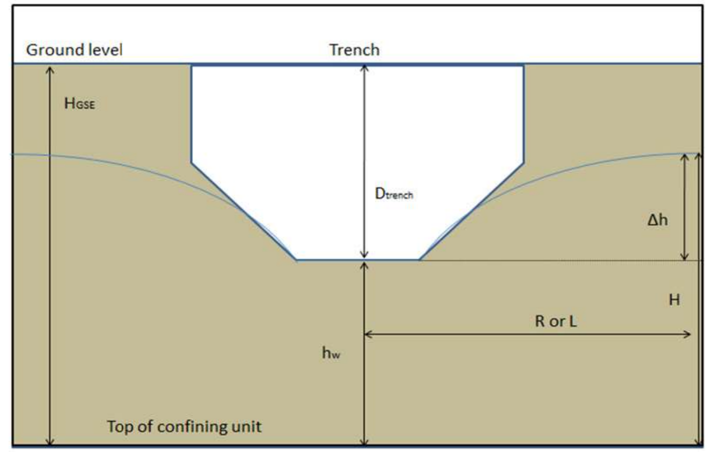
Δh (always ≥ 0)	11	ft	Eq. 1 - Radius of influence		
C	3	-/-	$R = C\ (\Delta h)\sqrt{k}$	15.9	ft/day
k	5.6E+01	µm/sec	k (Magothy, K)	5.6E-03	cm/sec
R, wit safety factor	123	ft	Safety Factor for R	0.5	Enter!

2. Calculation of estimated dewatering

H	25	ft
h_w	14	ft
k	1.8E-04	ft/sec
L	123	ft
Q	0.00054	cf/sec/ft
Q_{trench}	24.3	gpm

Eq.2 - Required dewatering

$$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$$



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft *(If trench bottom is below confining unit, then h_w = 0)*
Δh	H - h_w
R	Radius of influence, ft. R = L *(If trench bottom is above the static gw level, then R = 0, and Q = 0)*
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

Mag (H=50)

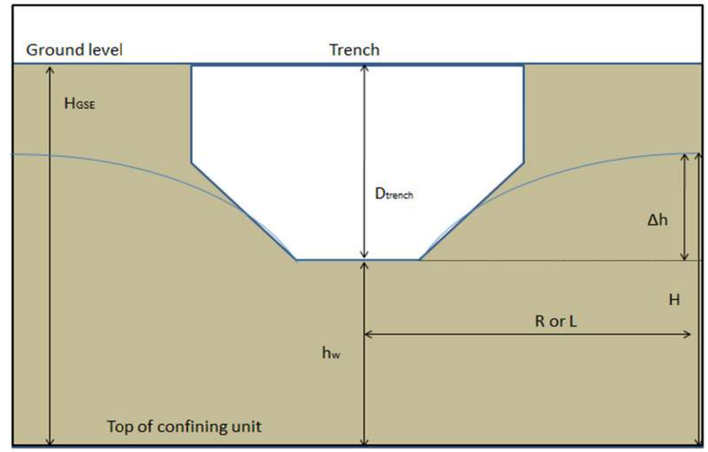
Feature ID	Trench Segment (100-ft)				
D_{trench}	12.0	ft	Ground EL	100	ft msl
L_{trench}	100	ft	GW EL	99	ft msl
			Add-on (Max. GW EL)	0.0	ft
			Trench Bottom	88	ft msl

1. Calculation of radius of influence

Δh (always ≥ 0)	11	ft	Eq. 1 - Radius of influence		
C	3	-/-	$R = C\ (\Delta h)\sqrt{k}$	15.9	ft/day
k	5.6E+01	µm/sec	k (Magothy, K)	5.6E-03	cm/sec
R, wit safety factor	123	ft	Safety Factor for R	0.5	

2. Calculation of estimated dewatering

H	50	ft	Eq.2 - Required dewatering
h_w	39	ft	$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$
k	1.8E-04	ft/sec	
L	123	ft	
Q	0.00115	cf/sec/ft	
Q_{trench}	51.6	gpm	



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft *(If trench bottom is below confining unit, then h_w = 0)*
Δh	$H - h_w$
R	Radius of influence, ft. R = L *(If trench bottom is above the static gw level, then R = 0, and Q = 0)*
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

Kmo (H = 10)

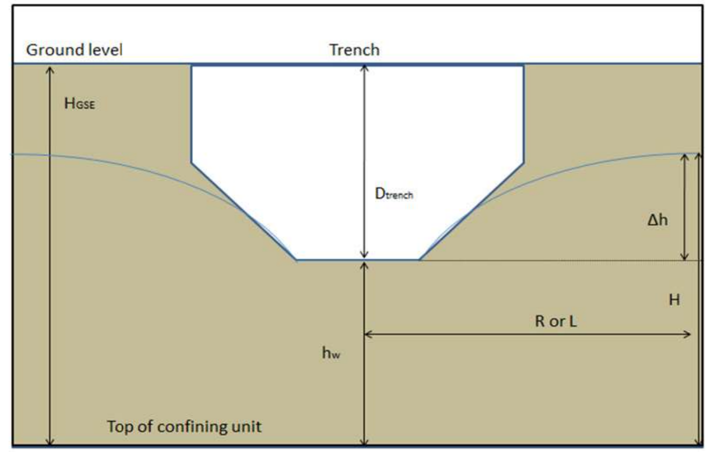
Feature ID	Trench Segment (100-ft)				
D_{trench}	12.0	ft	Ground EL	100	ft msl
L_{trench}	100	ft	GW EL	99	ft msl
			Add-on (Max. GW EL)	0.0	ft
			Trench Bottom	88	ft msl

1. Calculation of radius of influence

Δh (always ≥ 0)	11	ft	Eq. 1 - Radius of influence		
C	3	-/-	$R = C\ (\Delta h)\sqrt{k}$	43.5	ft/day
k	1.5E+02	µm/sec	k (Magothy, Kmo)	1.5E-02	cm/sec
R, wit safety factor	204	ft	Safety Factor for R	0.5	

2. Calculation of estimated dewatering

H	10	ft	Eq.2 - Required dewatering
h_w	-1	ft	$Q = \left(0.73 + 0.27\frac{H_\square - h_w}{H_\square}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$
k	5.0E-04	ft/sec	
L	204	ft	
Q	0.00025	cf/sec/ft	
Q_{trench}	11.2	gpm	



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft *(If trench bottom is below confining unit, then h_w = 0)*
Δh	H - h_w
R	Radius of influence, ft. R = L *(If trench bottom is above the static gw level, then R = 0, and Q = 0)*
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

AECOM

Kmo (H = 25)

Feature ID		Trench Segment (100-ft)		
D_{trench}	12.0 ft	Ground EL	100	ft msl
L_{trench}	100 ft	GW EL	99	ft msl
		Add-on (Max. GW EL)	0.0	ft
		Trench Bottom	88	ft msl

1. Calculation of radius of influence

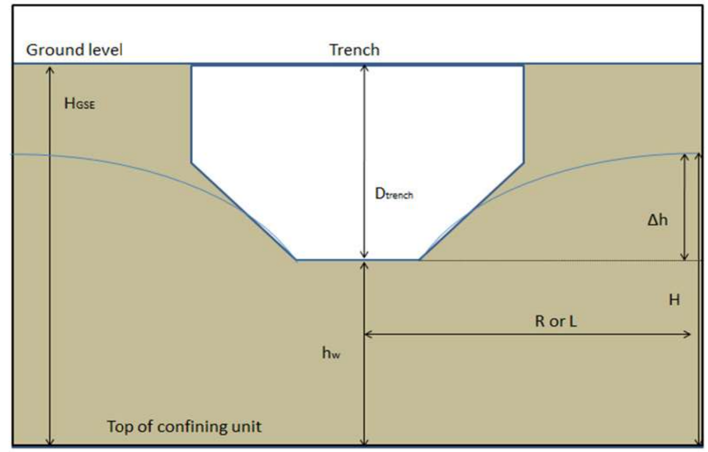
Δh (always ≥ 0)	11 ft	Eq. 1 - Radius of influence		
C	3 -/-	$R = C\ (\Delta h)\sqrt{k}$	43.5	ft/day
k	1.5E+02 µm/sec	k (Magothy, Kmo)	1.5E-02	cm/sec
R, wit safety factor	204 ft	Safety Factor for R	0.5	

2. Calculation of estimated dewatering

H	25	ft
h_w	14	ft
k	5.0E-04	ft/sec
L	204	ft
Q	0.00090	cf/sec/ft
Q_{trench}	40.3	gpm

Eq.2 - Required dewatering

$$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$$



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft *(If trench bottom is below confining unit, then h_w = 0)*
Δh	H - h_w
R	Radius of influence, ft. R = L *(If trench bottom is above the static gw level, then R = 0, and Q = 0)*
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

Kmo (H = 50)

Feature ID — **Trench Segment (100-ft)**

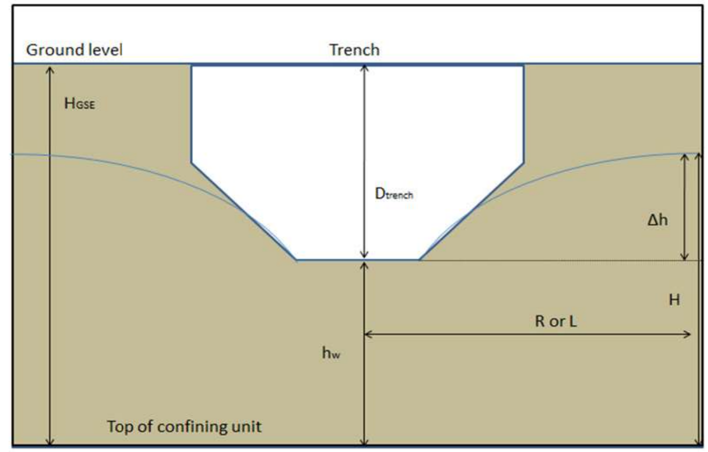
D_{trench}	12.0	ft	Ground EL	100	ft msl
L_{trench}	100	ft	GW EL	99	ft msl
			Add-on (Max. GW EL)	0.0	ft
			Trench Bottom	88	ft msl

1. Calculation of radius of influence

Δh (always ≥ 0)	11	ft	Eq. 1 - Radius of influence		
C	3	-/-	$R = C\ (\Delta h)\sqrt{k}$	43.5	ft/day
k	1.5E+02	µm/sec	k (Magothy, Kmo)	1.5E-02	cm/sec
R, wit safety factor	204	ft	Safety Factor for R	0.5	

2. Calculation of estimated dewatering

H	50	ft	Eq.2 - Required dewatering
h_w	39	ft	$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$
k	5.0E-04	ft/sec	
L	204	ft	
Q	0.00190	cf/sec/ft	
Q_{trench}	85.5	gpm	



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft *(If trench bottom is below confining unit, then h_w = 0)*
Δh	H - h_w
R	Radius of influence, ft. R = L *(If trench bottom is above the static gw level, then R = 0, and Q = 0)*
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

Kma (H = 10)

Feature ID			Trench Segment (100-ft)		
D_{trench}	12.0	ft	Ground EL	100	ft msl
L_{trench}	100	ft	GW EL	99	ft msl
			Add-on (Max. GW EL)	0.0	ft
			Trench Bottom	88	ft msl

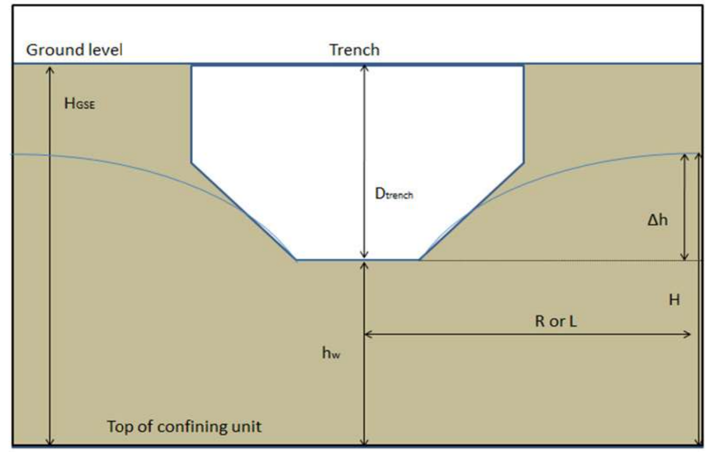
1. Calculation of radius of influence

Δh (always ≥ 0)	11	ft	Eq. 1 - Radius of influence		
C	3	-/-	$R = C\ (\Delta h)\sqrt{k}$	6.3	ft/day
k	2.2E+01	µm/sec	k (Magothy, Kma)	2.2E-03	cm/sec
R, wit safety factor	78	ft	Safety Factor for R	0.5	

2. Calculation of estimated dewatering

H	10	ft	Eq.2 - Required dewatering
h_w	-1	ft	
k	7.3E-05	ft/sec	
L	78	ft	
Q	0.00010	cf/sec/ft	
Q_{trench}	4.3	gpm	

$$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$$



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft *(If trench bottom is below confining unit, then h_w = 0)*
Δh	H - h_w
R	Radius of influence, ft. R = L *(If trench bottom is above the static gw level, then R = 0, and Q = 0)*
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

Kma (H = 25)

Feature ID — **Trench Segment (100-ft)**

D_{trench}	12.0	ft	Ground EL	100	ft msl
L_{trench}	100	ft	GW EL	99	ft msl
			Add-on (Max. GW EL)	0.0	ft
			Trench Bottom	88	ft msl

1. Calculation of radius of influence

Eq. 1 - Radius of influence

$$R = C\ (\Delta h)\sqrt{k}$$

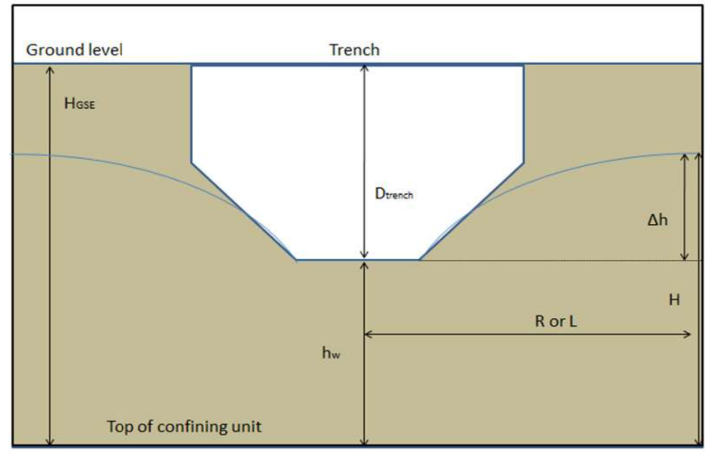
Δh (always ≥ 0)	11	ft			
C	3	-/-		6.3	ft/day
k	2.2E+01	µm/sec	k (Magothy, Kma)	2.2E-03	cm/sec
R, wit safety factor	78	ft	Safety Factor for R	0.5	

2. Calculation of estimated dewatering

Eq.2 - Required dewatering

$$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$$

H	25	ft
h_w	14	ft
k	7.3E-05	ft/sec
L	78	ft
Q	0.00034	cf/sec/ft
Q_{trench}	15.3	gpm



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft *(If trench bottom is below confining unit, then h_w = 0)*
Δh	H - h_w
R	Radius of influence, ft. R = L *(If trench bottom is above the static gw level, then R = 0, and Q = 0)*
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

Kma (H = 50)

Feature ID | **Trench Segment (100-ft)**

D_{trench}	12.0	ft	Ground EL	100	ft msl
L_{trench}	100	ft	GW EL	99	ft msl
			Add-on (Max. GW EL)	0.0	ft
			Trench Bottom	88	ft msl

1. Calculation of radius of influence

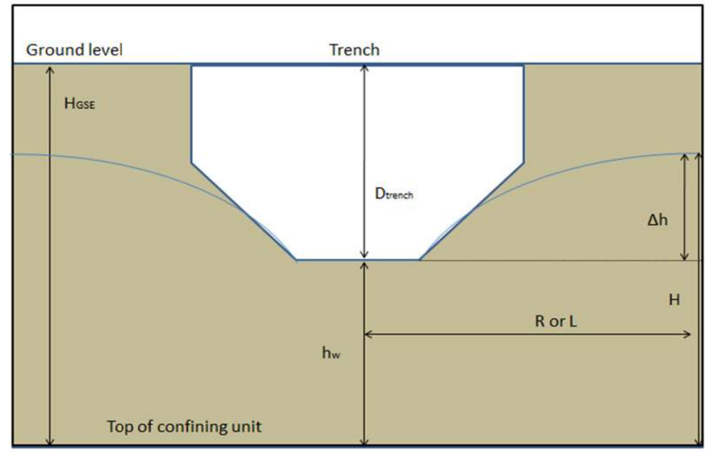
Δh (always ≥ 0)	11	ft	Eq. 1 - Radius of influence		
C	3	-/-	$R = C\ (\Delta h)\sqrt{k}$	6.3	ft/day
k	2.2E+01	µm/sec	k (Magothy, Kma)	2.2E-03	cm/sec
R, wit safety factor	**78**	ft	Safety Factor for R	0.5	

2. Calculation of estimated dewatering

H	50	ft
h_w	39	ft
k	7.3E-05	ft/sec
L	78	ft
Q	0.00072	cf/sec/ft
Q_{trench}	**32.5**	gpm

Eq.2 - Required dewatering

$$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$$



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft *(If trench bottom is below confining unit, then h_w = 0)*
Δh	H - h_w
R	Radius of influence, ft. R = L *(If trench bottom is above the static gw level, then R = 0, and Q = 0)*
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

Qal (H=10)

Feature ID | **Trench Segment (100-ft)**

D_{trench}	12.0	ft	Ground EL	100	ft msl
L_{trench}	100	ft	GW EL	99	ft msl
			Add-on (Max. GW EL)	0.0	ft
			Trench Bottom	88	ft msl

1. Calculation of radius of influence

Eq. 1 - Radius of influence

$$R = C\ (\Delta h)\sqrt{k}$$

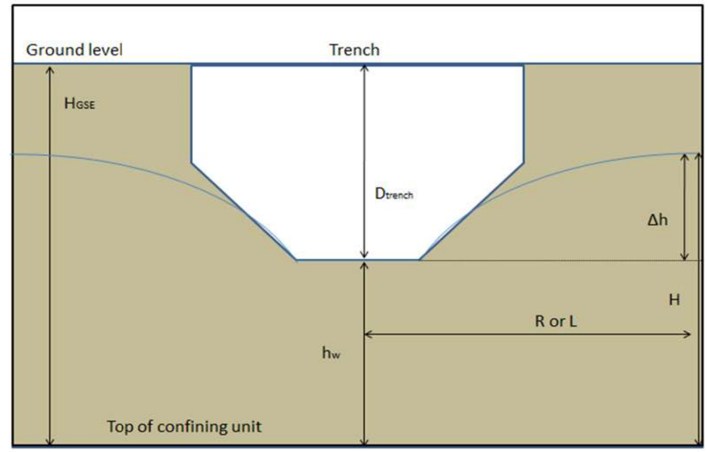
Δh (always $\geq$ 0)	11	ft			
C	3	-/-		99.2	ft/day
k	3.5E+02	µm/sec	k (Qal)	3.5E-02	cm/sec
R, wit safety factor	309	ft	Safety Factor for R	0.5	

2. Calculation of estimated dewatering

Eq.2 - Required dewatering

$$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$$

H	10	ft
h_w	-1	ft
k	1.1E-03	ft/sec
L	309	ft
Q	0.00038	cf/sec/ft
Q_{trench}	17.0	gpm



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft *(If trench bottom is below confining unit, then h_w = 0)*
Δh	H - h_w
R	Radius of influence, ft. R = L *(If trench bottom is above the static gw level, then R = 0, and Q = 0)*
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

Qal (H=25)

Feature ID	**Trench Segment (100-ft)**			
D_{trench}	12.0 ft		Ground EL	100 ft msl
L_{trench}	100 ft		GW EL	99 ft msl
			Add-on (Max. GW EL)	0.0 ft
			Trench Bottom	88 ft msl

1. Calculation of radius of influence

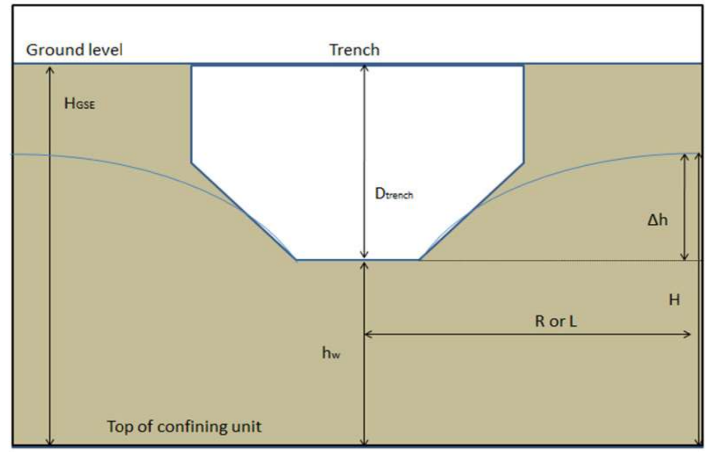
Δh (always ≥ 0)	11 ft	Eq. 1 - Radius of influence	
C	3 -/-	$R = C\ (\Delta h)\sqrt{k}$	99.2 ft/day
k	3.5E+02 µm/sec	k (Qal)	3.5E-02 cm/sec
R, wit safety factor	**309** ft	Safety Factor for R	0.5

2. Calculation of estimated dewatering

H	25 ft
h_w	14 ft
k	1.1E-03 ft/sec
L	309 ft
Q	0.00135 cf/sec/ft
Q_{trench}	**60.8** gpm

Eq.2 - Required dewatering

$$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$$



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft
	(If trench bottom is below confining unit, then h_w = 0)
Δh	H - h_w
R	Radius of influence, ft. R = L
	(If trench bottom is above the static gw level, then R = 0, and Q = 0)
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

Qal (H=50)

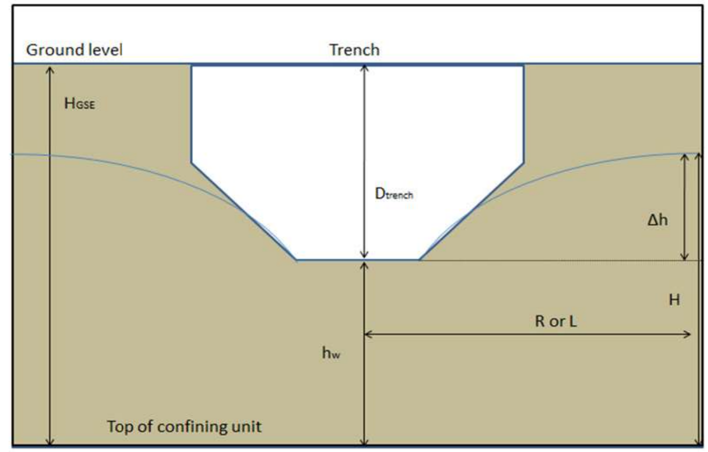
Feature ID	Trench Segment (100-ft)				
D_{trench}	12.0	ft	Ground EL	100	ft msl
L_{trench}	100	ft	GW EL	99	ft msl
			Add-on (Max. GW EL)	0.0	ft
			Trench Bottom	88	ft msl

1. Calculation of radius of influence

Δh (always ≥ 0)	11	ft	Eq. 1 - Radius of influence		
C	3	-/-	$R = C\ (\Delta h)\sqrt{k}$	99.2	ft/day
k	3.5E+02	µm/sec	k (Qal)	3.5E-02	cm/sec
R, wit safety factor	309	ft	Safety Factor for R	0.5	

2. Calculation of estimated dewatering

H	50	ft	Eq.2 - Required dewatering
h_w	39	ft	$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$
k	1.1E-03	ft/sec	
L	309	ft	
Q	0.00287	cf/sec/ft	
Q_{trench}	129.0	gpm	



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft *(If trench bottom is below confining unit, then h_w = 0)*
Δh	H - h_w
R	Radius of influence, ft. R = L *(If trench bottom is above the static gw level, then R = 0, and Q = 0)*
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

Feature ID	Trench Segment (100-ft)				
D_{trench}	12.0	ft	Ground EL	100	ft msl
L_{trench}	100	ft	GW EL	99	ft msl
			Add-on (Max. GW EL)	0.0	ft
			Trench Bottom	88	ft msl

1. Calculation of radius of influence

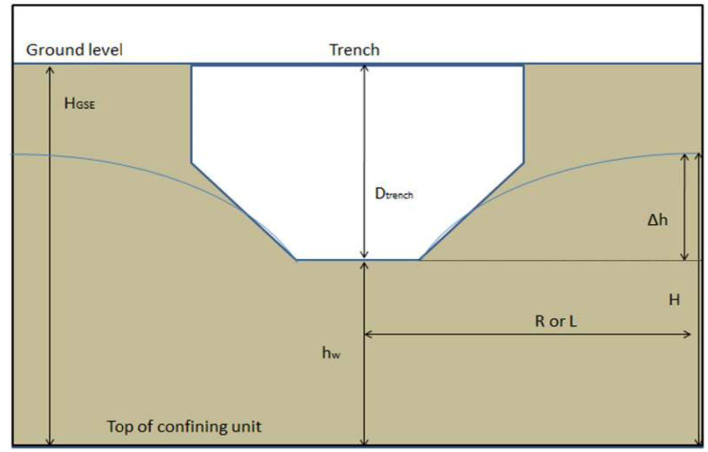
Δh (always ≥ 0)	11	ft	Eq. 1 - Radius of influence		
C	3	-/-	$R = C\ (\Delta h)\sqrt{k}$	79.3	ft/day
k	2.8E+02	µm/sec	k (Magothy, K)	2.8E-02	cm/sec
R, wit safety factor	276	ft	Safety Factor for R	0.5	

2. Calculation of estimated dewatering

H	10	ft
h_w	-1	ft
k	9.2E-04	ft/sec
L	276	ft
Q	0.00034	cf/sec/ft
Q_{trench}	15.2	gpm

Eq.2 - Required dewatering

$$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$$



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft *(If trench bottom is below confining unit, then h_w = 0)*
Δh	H - h_w
R	Radius of influence, ft. R = L *(If trench bottom is above the static gw level, then R = 0, and Q = 0)*
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

AECOM

Mag (H=25)

Feature ID — **Trench Segment (100-ft)**

D_{trench}	12.0	ft	Ground EL	100	ft msl
L_{trench}	100	ft	GW EL	99	ft msl
			Add-on (Max. GW EL)	0.0	ft
			Trench Bottom	88	ft msl

1. Calculation of radius of influence

Eq. 1 - Radius of influence

$$R = C\ (\Delta h)\sqrt{k}$$

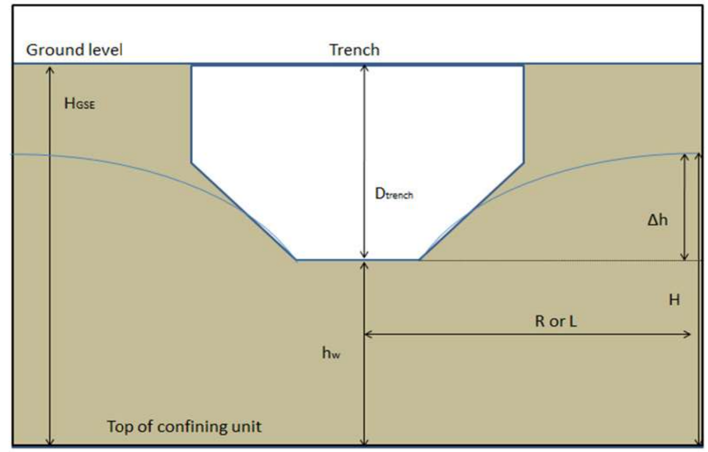
Δh (always ≥ 0)	11	ft			
C	3	-/-		79.3	ft/day
k	2.8E+02	µm/sec	k (Magothy, K)	2.8E-02	cm/sec
R, wit safety factor	276	ft	Safety Factor for R	0.5	Enter!

2. Calculation of estimated dewatering

Eq.2 - Required dewatering

$$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$$

H	25	ft
h_w	14	ft
k	9.2E-04	ft/sec
L	276	ft
Q	0.00121	cf/sec/ft
Q_{trench}	54.4	gpm



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft
	(If trench bottom is below confining unit, then h_w = 0)
Δh	H - h_w
R	Radius of influence, ft. R = L
	(If trench bottom is above the static gw level, then R = 0, and Q = 0)
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

Feature ID | **Trench Segment (100-ft)**

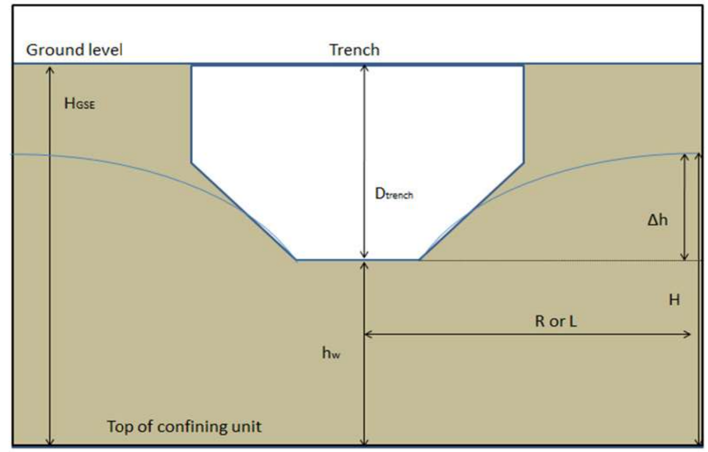
D_{trench}	12.0	ft	Ground EL	100	ft msl
L_{trench}	100	ft	GW EL	99	ft msl
			Add-on (Max. GW EL)	0.0	ft
			Trench Bottom	88	ft msl

1. Calculation of radius of influence

Δh (always ≥ 0)	11	ft	Eq. 1 - Radius of influence		
C	3	-/-	$R = C\ (\Delta h)\sqrt{k}$	79.3	ft/day
k	2.8E+02	µm/sec	k (Magothy, K)	2.8E-02	cm/sec
R, wit safety factor	276	ft	Safety Factor for R	0.5	

2. Calculation of estimated dewatering

H	50	ft	Eq.2 - Required dewatering
h_w	39	ft	$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$
k	9.2E-04	ft/sec	
L	276	ft	
Q	0.00257	cf/sec/ft	
Q_{trench}	115.4	gpm	



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft
	(If trench bottom is below confining unit, then h_w = 0)
Δh	H - h_w
R	Radius of influence, ft. R = L
	(If trench bottom is above the static gw level, then R = 0, and Q = 0)
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

Kmo (H = 10)

Feature ID	Trench Segment (100-ft)				
D_{trench}	12.0	ft	Ground EL	100	ft msl
L_{trench}	100	ft	GW EL	99	ft msl
			Add-on (Max. GW EL)	0.0	ft
			Trench Bottom	88	ft msl

1. Calculation of radius of influence

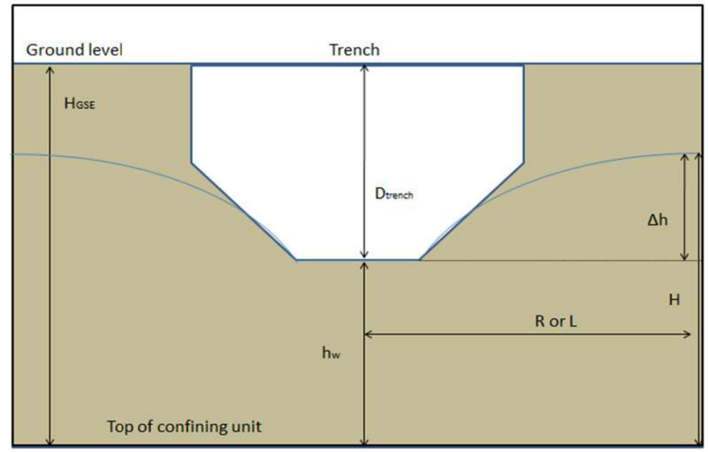
Δh (always ≥ 0)	11	ft	Eq. 1 - Radius of influence		
C	3	-/-	$R = C\ (\Delta h)\sqrt{k}$	217.7	ft/day
k	7.7E+02	µm/sec	k (Magothy, Kmo)	7.7E-02	cm/sec
R, wit safety factor	457	ft	Safety Factor for R	0.5	

2. Calculation of estimated dewatering

H	10	ft
h_w	-1	ft
k	2.5E-03	ft/sec
L	457	ft
Q	0.00056	cf/sec/ft
Q_{trench}	25.1	gpm

Eq.2 - Required dewatering

$$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$$



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft *(If trench bottom is below confining unit, then h_w = 0)*
Δh	H - h_w
R	Radius of influence, ft. R = L *(If trench bottom is above the static gw level, then R = 0, and Q = 0)*
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

Kmo (H = 25)

Feature ID	Trench Segment (100-ft)				
D_{trench}	12.0	ft	Ground EL	100	ft msl
L_{trench}	100	ft	GW EL	99	ft msl
			Add-on (Max. GW EL)	0.0	ft
			Trench Bottom	88	ft msl

1. Calculation of radius of influence

Eq. 1 - Radius of influence

$$R = C\ (\Delta h)\sqrt{k}$$

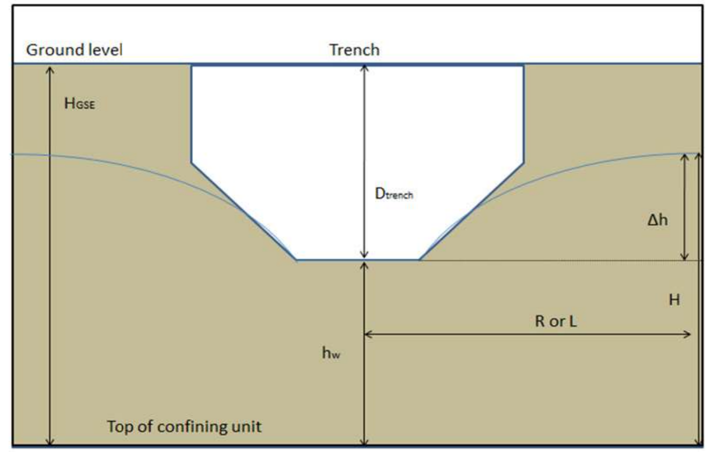
Δh (always > 0)	11	ft			
C	3	-/-		217.7	ft/day
k	7.7E+02	µm/sec	k (Magothy, Kmo)	7.7E-02	cm/sec
R, wit safety factor	457	ft	Safety Factor for R	0.5	

2. Calculation of estimated dewatering

Eq.2 - Required dewatering

$$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$$

H	25	ft
h_w	14	ft
k	2.5E-03	ft/sec
L	457	ft
Q	0.00201	cf/sec/ft
Q_{trench}	90.0	gpm



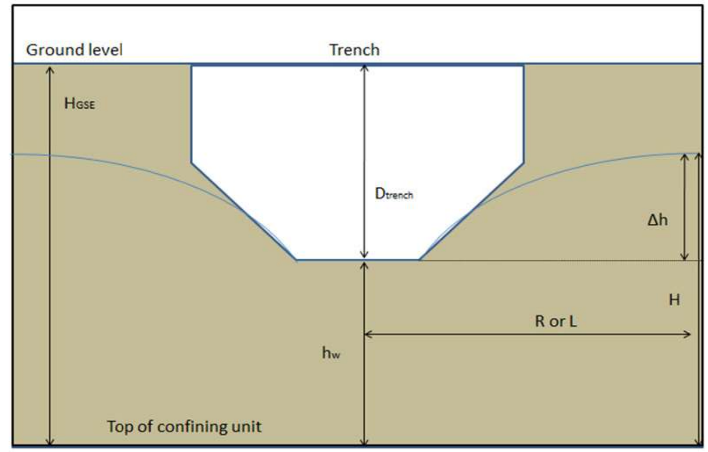
H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft
	(If trench bottom is below confining unit, then h_w = 0)
Δh	$H - h_w$
R	Radius of influence, ft. R = L
	(If trench bottom is above the static gw level, then R = 0, and Q = 0)
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

Kmo (H = 50)

Feature ID	Trench Segment (100-ft)				
D_{trench}	12.0	ft	Ground EL	100	ft msl
L_{trench}	100	ft	GW EL	99	ft msl
			Add-on (Max. GW EL)	0.0	ft
			Trench Bottom	88	ft msl

1. Calculation of radius of influence			Eq. 1 - Radius of influence		
Δh (always $\geq$ 0)	11	ft			
C	3	-/-	$R = C\ (\Delta h)\sqrt{k}$	217.7	ft/day
k	7.7E+02	µm/sec	k (Magothy, Kmo)	7.7E-02	cm/sec
R, wit safety factor	457	ft	Safety Factor for R	0.5	

2. Calculation of estimated dewatering			Eq.2 - Required dewatering
H	50	ft	$$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$$
h_w	39	ft	
k	2.5E-03	ft/sec	
L	457	ft	
Q	0.00426	cf/sec/ft	
Q_{trench}	191.1	gpm	



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft
	(If trench bottom is below confining unit, then h_w = 0)
Δh	H - h_w
R	Radius of influence, ft. R = L
	(If trench bottom is above the static gw level, then R = 0, and Q = 0)
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

Kma (H = 10)

Feature ID | **Trench Segment (100-ft)**

D_{trench}	12.0	ft	Ground EL	100	ft msl
L_{trench}	100	ft	GW EL	99	ft msl
			Add-on (Max. GW EL)	0.0	ft
			Trench Bottom	88	ft msl

1. Calculation of radius of influence

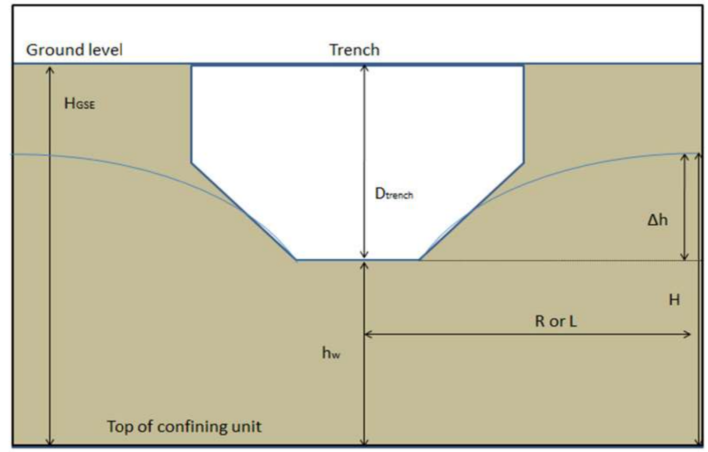
Δh (always $\geq$ 0)	11	ft	Eq. 1 - Radius of influence		
C	3	-/-	$R = C\,(\Delta h)\sqrt{k}$	31.5	ft/day
k	1.1E+02	µm/sec	k (Magothy, Kma)	1.1E-02	cm/sec
R, wit safety factor	174	ft	Safety Factor for R	0.5	

2. Calculation of estimated dewatering

H	10	ft
h_w	-1	ft
k	3.6E-04	ft/sec
L	174	ft
Q	0.00021	cf/sec/ft
Q_{trench}	9.6	gpm

Eq.2 - Required dewatering

$$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$$



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft *(If trench bottom is below confining unit, then h_w = 0)*
Δh	H - h_w
R	Radius of influence, ft. R = L *(If trench bottom is above the static gw level, then R = 0, and Q = 0)*
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

Kma (H = 25)

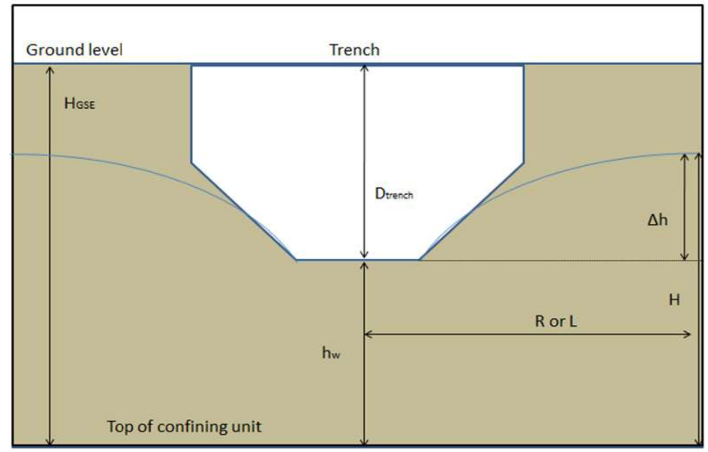
Feature ID	Trench Segment (100-ft)				
D_{trench}	12.0	ft	Ground EL	100	ft msl
L_{trench}	100	ft	GW EL	99	ft msl
			Add-on (Max. GW EL)	0.0	ft
			Trench Bottom	88	ft msl

1. Calculation of radius of influence

Δh (always ≥ 0)	11	ft	Eq. 1 - Radius of influence		
C	3	-/-	$R = C\ (\Delta h)\sqrt{k}$	31.5	ft/day
k	1.1E+02	µm/sec	k (Magothy, Kma)	1.1E-02	cm/sec
R, wit safety factor	174	ft	Safety Factor for R	0.5	

2. Calculation of estimated dewatering

H	25	ft	Eq.2 - Required dewatering
h_w	14	ft	$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$
k	3.6E-04	ft/sec	
L	174	ft	
Q	0.00076	cf/sec/ft	
Q_{trench}	34.3	gpm	



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft *(If trench bottom is below confining unit, then h_w = 0)*
Δh	H - h_w
R	Radius of influence, ft. R = L *(If trench bottom is above the static gw level, then R = 0, and Q = 0)*
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

Kma (H = 50)

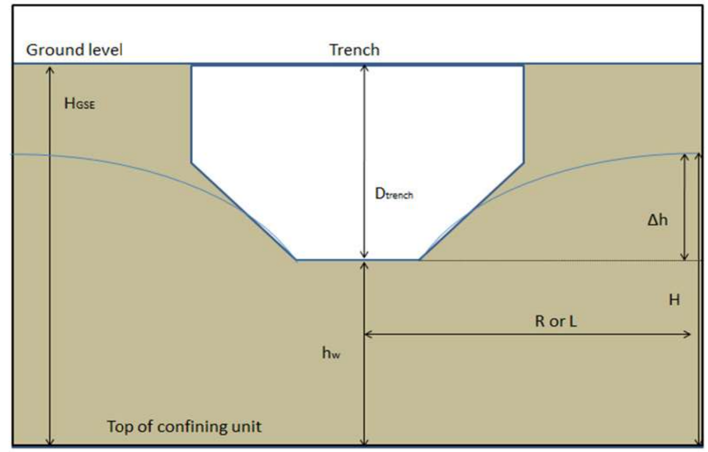
Feature ID	Trench Segment (100-ft)				
D_{trench}	12.0	ft	Ground EL	100	ft msl
L_{trench}	100	ft	GW EL	99	ft msl
			Add-on (Max. GW EL)	0.0	ft
			Trench Bottom	88	ft msl

1. Calculation of radius of influence

Δh (always ≥ 0)	11	ft	Eq. 1 - Radius of influence		
C	3	-/-	$R = C\ (\Delta h)\sqrt{k}$	31.5	ft/day
k	1.1E+02	µm/sec	k (Magothy, Kma)	1.1E-02	cm/sec
R, wit safety factor	174	ft	Safety Factor for R	0.5	

2. Calculation of estimated dewatering

H	50	ft	Eq.2 - Required dewatering
h_w	39	ft	$Q = \left(0.73 + 0.27\frac{H_{\square} - h_w}{H_{\square}}\right)\frac{k}{2L}(H^2 - h_w^2) * 2$
k	3.6E-04	ft/sec	
L	174	ft	
Q	0.00162	cf/sec/ft	
Q_{trench}	72.7	gpm	



H	Static groundwater level above confining layer, ft
H_{GSE}	Ground surface above confining layer, ft
h_w	Pumped gw level above confining unit, ft
	(If trench bottom is below confining unit, then h_w = 0)
Δh	H - h_w
R	Radius of influence, ft. R = L
	(If trench bottom is above the static gw level, then R = 0, and Q = 0)
C	C = 3 for gravity flow wells
k	coefficient of permeability, in units shown
Q	Estimated detwatering (pumping), gpm per unit length of trench
Q_{trench}	Estimated dewatering from entire trench length, gpm
L_{trench}	Length of trench
D_{trench}	Depth of trench

Dupuit - Forchheimer Approximation

$$Q = n \cdot q = \frac{\pi \cdot k \cdot \left(H^2 - h^2\right)}{\ln\left(\frac{R_O}{r_e}\right)}$$

(1) Forchheimer - Dupuit Equation

$$R_O = C \cdot (H - h) \cdot \sqrt{k} + r_e$$

C = 3,000 for an unconfined aquifer and standard metric units

(2) Sichardt Equation
Radius of Influence

$$r_e = \sqrt{\frac{a \cdot b}{\pi}}$$

(3) Effective Radius

Definition of Terms:

- Q = overall flow rate [m^3/s]
- n = number of well points/sumps
- q = flow rate per well point [m^3/s]
- k = hydraulic conductivity [m/s]
- H = total head of the water table aquifer [m]
- h = total head of dewatered aquifer [m]
- R_O = radius of influence [m]
- r_e = effective radius of dewatering [m]
- a = width of proposed excavation [m]
- b = length of proposed excavation [m]

References:
(1) An Introduction to Geotechnical Processes by John Woodward
(2) GeoEnvironmental Engineering Site Remediation, by Hari Sharma and Krishna Reddy

Dewatering Scenarios

	Input Values (in US units)								Output Values								
Feature ID	a	b	k	Aquitard Elevation	Ground Surf. Elev.	Groundwater Elev.	Excavation Depth	Bottom of Excavation Elev.	a	b	H	h	Drawdown (H-h)	R_O	r_e	Q	Q
	ft	ft	ft/day	ft msl	ft msl	ft msl	ft	ft msl	m	m	m	m	m	m	m	m^3/s	gpm
GSDB Exit (240.90)	10	10	6.3	75.0	100	99	15	85.0	3.05	3.05	7.32	3.05	4.27	62.1	1.7	8.6E-04	13.7
GDDB Entry (249.00)	10	10	44	75.0	100	99	9	91.0	3.05	3.05	7.32	4.88	2.44	92.4	1.7	3.6E-03	57.1
GDDB Exit (250.90)	10	10	44	75.0	100	99	9	91.0	3.05	3.05	7.32	4.88	2.44	92.4	1.7	3.6E-03	57.1
HDD Entry (253.02)	15	10	87	75.0	100	99	12	88.0	4.6	3.0	7.3	4.0	3.35	178.5	2.1	8.2E-03	130

Footprint of conventional DB bore pits were assumed to be 10 ft x 10 ft; the excavation depths of the bore pits were provided by Transco
Footprint of HDD entry/exit pits were assumed to be 15 ft x 10 ft; the excavation depths of the bore pits were provided by Transco